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Rifle range construction

H. C. Wilson,
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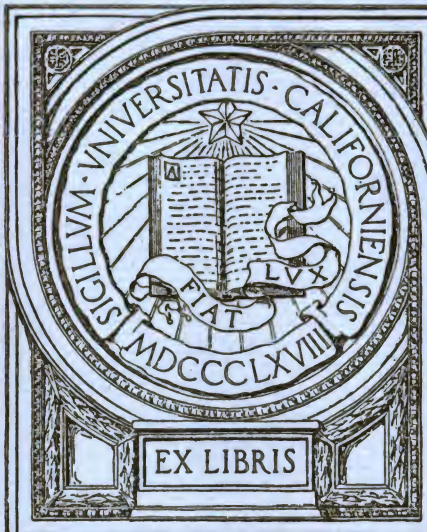

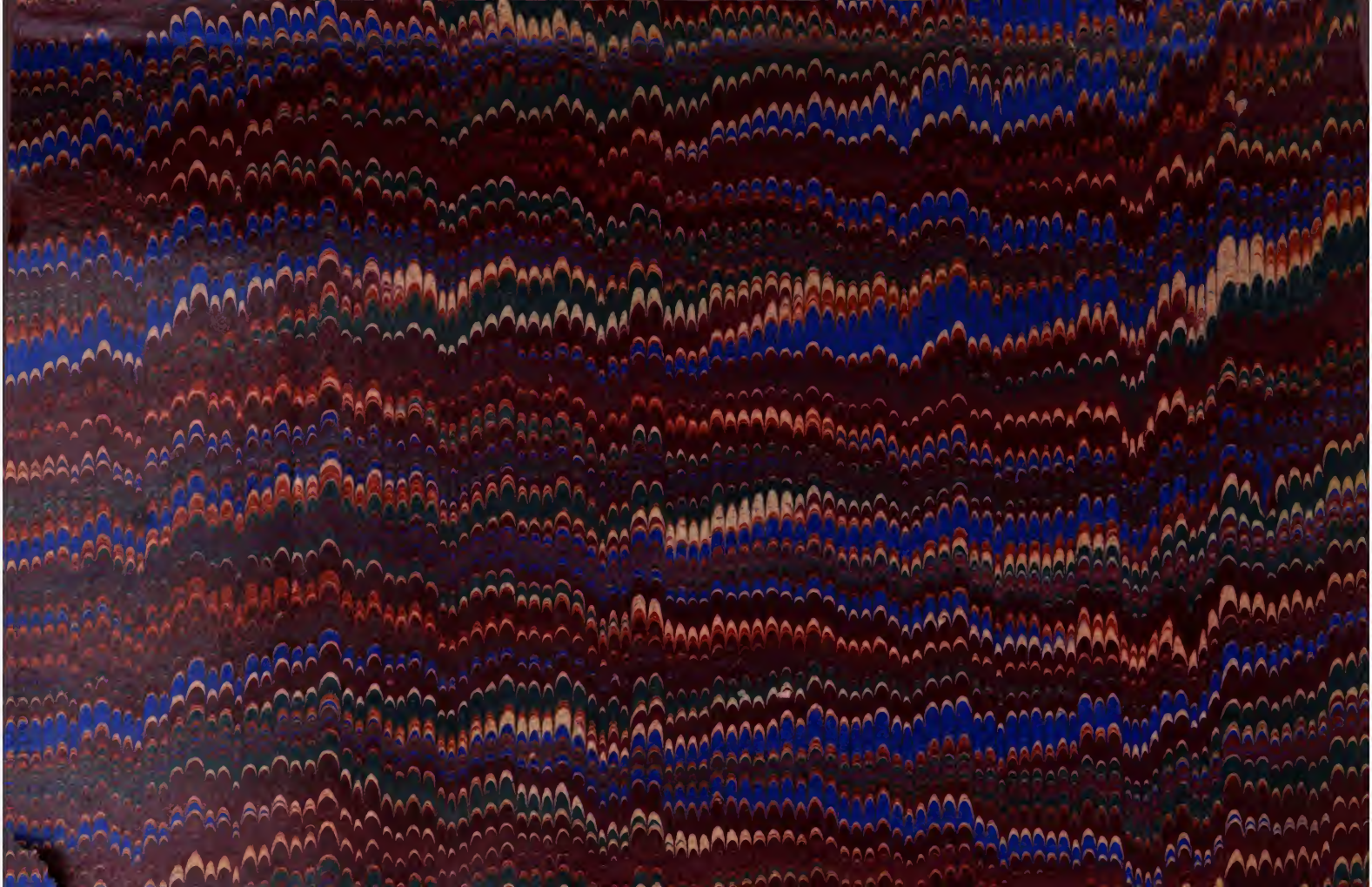

RIFLE RANGE CONSTRUCTION

A TEXT-BOOK

TO BE USED IN THE CONSTRUCTION OF

RIFLE RANGES

WITH DETAILS OF ALL PARTS OF THE WORK

Univ. of California

COMPILED BY

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PRICE $1.00

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DEDICATION.

This book is dedicated to the range builders: Men who are toiling and struggling with almost superhuman energy to do something for our nation's need; men who have been far-sighted enough to see that while we are almost, if not quite, the most arrogant nation in the world, we are also the most helpless if war should come; men who believe in peace, who desire peace, and who are trying to insure our country against war, and are therefore willing to spend a few trifling millions now to prevent our paying hundreds of millions later on; men who know that rifle practice makes for clean sportsmanship, healthfulness, and temperance; men whom our country will some day rise up and call blessed.

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INTRODUCTION.

Preparing a nation for absolute defense is apparently most costly; but trying to place one in that condition by the expenditure of only one-third or one-half of the amount required is not only wasteful extravagance but almost criminal negligence.

The use of that overworked word "militarism" has abated much in the past few years. Our people as a nation seem to be beginning to realize the need of making *some* progress in the art of war. The word "some" must be printed in very small letters, but it is a million times larger than a negative, and, therefore, there is hope that we will finally realize what *peace insurance* is worth and appropriate sufficient money to obtain it.

Practice and rehearsals are needful for any act in life which we wish to perform well: the wedding; the prize fight; the oration; all sports; all arts; all professions. And yet war; terrible, fearful, awful war; war, which for ages has been a science and never so much so as now, is to be waged, according to the ideas of many of our statesmen, by assembling an unorganized mob of impractical, unrehearsed men, putting rifles in its hands and sending it out to annihilate an enemy, with no more chance than a snow-ball would have in the place which is paved with good intentions.

Our service rifle is unexcelled. Our ammunition the

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best in the world. Americans can shoot—*after systematic training* for two or three years.

President Roosevelt in his last message to Congress said:

"It is unfortunately true that the great body of our citizens shoot less and less as time goes on.

"To meet this we should encourage rifle practice among schoolboys, and indeed among all classes, as well as in the military services, by every means in our power. Thus, and not otherwise, may we be able to assist in preserving the peace of the world. . . . . Unprepared, and therefore unfit, we must sit dumb and helpless to defend ourselves, protect others or preserve peace. The first step—in the direction of preparation to avert war, if possible, and to be fit for war if it should come—is to teach our men to shoot."

Changes are taking place so rapidly in our small arms firing that what appeared to be an established fact yesterday is found obsolete to-day. 1907 conditions, with the rounded 220 grain bullet and 2200 feet per second velocity, have yielded to those of 1908; the 150 grain sharp-pointed bullet and 2700 feet per second velocity. Judging from results at Camp Perry and Sea Girt, the model of 1906 ammunition is yet in its initial stage, and we may expect a rifle and ammunition developing a velocity of 2900 or 3000 feet per second.

When one reviews the past eight years in rifle shooting, the continued development in interest, in rifles, and in ammunition is astonishing. In 1901, thanks to the Ordnance Department, we had a first-class rifle, the "Krag," but the ammunition assembled was the "worst

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ever." The powder—"W.-A. .30 Cal."—was excellent; but the three-cannelured bullet and the so-called lubricant made holding elevations almost impossible. That year we lost the Palma Trophy to Canada. Early in 1902 the "rifle cranks"—there were relatively very few of them in those days—went into consultation, and, consequently, in September the U. S. Palma Trophy Team took to Canada what was considered excellent ammunition. The match was won by England because our rifle-men knew nothing about "*mirage*"; in fact, had never heard of it.

In 1903 we sent a team to England and won the Palma Trophy. (Owing to a slight controversy about the rifle barrels used in this match the trophy was afterward returned.) The ammunition used by the American Team in this match was considered the best ever assembled and was the product of an ammunition company; it was so good, in fact, that all military riflemen thought we had reached the limit and that nothing better could be made.

The few ranges which were building then were designed for a 2200 feet per second velocity safety.

Then the ever progressive Ordnance Department issued the "New Springfield." Better mechanism; double lugs; shorter barrel. This meant new ammunition, and from 1903 to 1908 we stumbled along on account of poor bullets, increasing the velocity always but falling down on accuracy, until in 1908 in a competitive trial another ammunition company won out with what was considered the best military ammunition yet produced. This was used by our Olympic Team which won against the world at Bisley, England, last year.

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And so the march of progress in rifle and ammunition advances with astonishing rapidity. In all probability, the National Matches of 1911 will be shot with cartridges developing a velocity of 3000 feet per second. This will mean more careful attention to range construction, more land or water to the rear of the butts, or much higher backstop. We have tried to cover all this in the work herewith presented.

Since January 1, 1905, the number of military targets in the United States has increased 300 per cent., and yet we are still wofully behind in targets compared with any other first-class power. We are still more wofully lacking in what is considered a modern range abroad: a range equipped with disappearing and surprise targets, where actual service conditions can be simulated. If we are to retain any supremacy in rifle shooting, such ranges must be built. Our ranges and our small arms practice to-day are only in the kindergarten class. Fixed distances and nicely leveled ground furnish excellent conditions for trying out rifles and ammunition but give no real military practice. The ranges of the future should be provided not only with targets for fixed distance shooting up to 1200 or 1500 yards, but also with surprise and disappearing targets, and some general plans are outlined in this book.

As stated in the opening paragraph of this introduction, changes are taking place so rapidly in our small arms firing that what appeared to be an established fact yesterday is found obsolete to-day. This must be considered in some minor details of the book herewith presented. For instance, the "Ideal Range"

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has a skirmish bank. The Small Arms Firing Regulations still provide for this, and yet it is practically obsolete as far as the National Match and practice for same is concerned.

It is hoped the work will be helpful to the men to whom it is dedicated.

J. G. EWING.

WILMINGTON, DELAWARE.
SEPTEMBER, 1909.

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RIFLE RANGE CONSTRUCTION.

CHAPTER I.

General Remarks.

1. The size and general character of the range to be built will be largely determined by the number of men that are expected to use the range, with reasonable consideration for future growth. From several sites that may be available, the one finally selected should be, first, most readily accessible as regards time and cheapness of transportation, and, next, that having the greatest degree of safety to persons outside of the range as well as the marksmen themselves. It is evident that a site requiring a long ride or considerable walking to reach, with possibly infrequent train or trolley service, would not be regarded with favor, unless the other considerations overweighed these inconveniences—but the prime element of safety must never be lost sight of.

2. Generally, the safety of a range depends upon the direction of fire or the style of backstop and what is beyond. When the firing may be toward a high hill or a large body of water, preferably not navigable, it should be considered as reasonably safe; likewise, swamp or waste meadow-land, etc., of sufficient area. Where these natural fields of safety do not contain backstops, artificial ones must be considered, and will be specifically referred to in the proper chapter. Absolute safety is

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out of the question, as there is always the possibility of a wild shot, especially in rapid fire, where the angle of fire is apt to be great and no backstop except a mountain-side is high enough to insure its catching all shots. So a natural backstop of 100 feet or a constructed backstop of 40 feet is considered sufficiently high.

3. It is assumed that competent authority will have in hand the selection and purchase or lease of the necessary ground and rights or privileges, after which there should be secured the services of a surveyor and engineer, preferably in consultation with some one who has attended matches at one of the great National ranges. Having in detail a map of the terrain, plan or profile, and possibly bird's-eye view photographs, the plan of the range should be developed, using for reference the several types of model ranges presented in chapter II, with such variations as may be necessary. The next step will be the completion of the working plans and specifications.

4. In this work the engineer should be familiar with the local market as regards material, labor, etc. Advantage should be taken by the engineer of conditions existing on or near the site of the range affording economy of construction, with special reference to the pits and butts. The prime advantage of surface pits over sunken target pits is that the former are readily drained, while frequently continued rain-fall may make it almost impossible to occupy the sunken pits. Most of the earth for the embankment in front of the sunken pit may be secured from the excavation, whereas the earth necessary for the surface pit may involve con-

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siderable haulage and handling. Attention is called to the fact that elevation of the firing-lines insures proper drainage, and, at the same time, lessens the expense of cutting the grass. Better protection is afforded the markers by entirely enclosing the target pits, although the added expense is seldom justifiable.

5. The questions of range buildings and sanitary arrangements depend upon local conditions, and are treated under the proper headings.

6. The recommendation of a 900 yard range is made, since some States require that qualification range, and it is also included in numerous matches.

7. The reference to special construction of a skirmish bank and the establishment of a separate set of stakes for skirmish firing is given for the sake of completeness. Where such construction is unnecessary owing to contemplated changes in regulations it can simply be left out, but, at the present time, it has not been definitely settled as to just which method is preferable.

8. In all the ranges recommended the extreme range is 1000 yards. This is governed by the present regulations for small arms firing. But where locality can provide such distances it might be well to locate the range so that at some future time 1100 and 1200 yard ranges can be provided. In fact, if it is possible to get 1500 yards it might be well to do it, as it is a question of but a short while when there will be some firing done at these distances. Establishing a range with these extreme distances does not in any way affect the general proposition nor the details of construction of pits and firing lines, so no special reference need be made to this end.

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9. The following data will be found of value to the engineer in the development of his plans and specifications:

MAXIMUM RANGE.

(COMPUTED.)

Maximum Range.	Elevation.	Time of Flight.
5465.8 yards.	45 degrees.	31.359 seconds.

PENETRATION OF 1906 BULLET (2700 FEET PER SECOND).

Material.	Penetration.			
	50 feet. Inches.	100 yds. Inches.	500 yds Inches.	1000 yds. Inches.
White pine boards, 1 inch thick, spaced 1 inch apart	33.5	46.7	24.3	12.8
Moist sand	8.7	..	13.4	12.5
Dry sand	4.0	..	9.2	7.5
Loam practically free from sand	14.0	...	18.8	18.6
Low steel plates,				
.493 in. thick	.446	.259	..	..
.3843 in. thick	Through	Through	..	..
.3062 in. thick	Through	Through	..	..
High steel plates,				
.3848 in. thick	Through	.241	..	..
.1962 in. thick	Through	Through	...	..
Thoroughly seasoned oak across the grain	12.2	33.6	..	..
Brick wall	..	5.0	..	..

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TRAJECTORY.

Range.		Extreme Ordinate of Trajectory Above Line of Sight.	
200 yds.	.....at	100 yds.	.238 ft.
300 "	..... "	200 "	.545 "
400 "	..... "	200 "	1.165 "
500 "	..... "	300 "	2.001 "
600 "	..... "	300 "	3.240 "
700 "	..... "	400 "	4.982 "
800 "	..... "	500 "	7.209 "
900 "	..... "	500 "	10.414 "
1000 "	..... "	600 "	14.423 "
1100 "	..... "	600 "	19.415 "
1200 "	..... "	700 "	25.824 "
1300 "	..... "	800 "	33.294 "
1400 "	..... "	800 "	42.272 "
1500 "	..... "	900 "	52.751 "
1600 "	..... "	900 "	64.604 "
1700 "	..... "	1000 "	78.605 "
1800 "	..... "	1100 "	94.010 "
1900 "	..... "	1100 "	111.886 "
2000 "	..... "	1200 "	131.672 "

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CHAPTER II.

The Model Rifle Range.

10. A model rifle range is here presented, having the desirable features of accessibility, safety, ease and economy of construction, proper direction of line of fire, correct sanitary conditions, and, by virtue of the lay-out of targets and firing-lines, the greatest flexibility of use, permitting firing either at all ranges at one time, or, firing at the maximum number of targets at one range. Plate I shows a plan of a range of this type.

11. The range proper is a rectangle 1728 feet in width by 1000 yards in length, divided into six longitudinal strips each 288 feet in width. On the right of this is another smaller rectangle of 200 yards in length and 288 feet in width, and on the right of this another rectangle 75 yards in length by 88 feet in width. This extreme right section is for pistol and revolver shooting only. The next section is for 200 yards shooting either slow or rapid fire or timed fire, and is intended to be used as a separate and distinct part of the range. It is the larger rectangle which is adapted to the combination of uses. The strip on the right measuring 288 feet by 1000 yards is known as the 300 yard range; the second section, the 500 yard range; the third section, the 600 yard; the fourth section, the 800 yard; the fifth section, the 1000 yard; and the sixth and last section, the skirmish range. These are the permanent designations of these strips.

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12. The line established by the 1000 yard butt on the fifth strip is carried the entire width of the rectangle, the butt construction allowing for ten long range targets with twenty-four feet between centers in each width of 288 feet. This gives a clear space of thirty feet from the extreme end of the targets to the dividing line between the rectangles. This is to allow the wind-flags to fly their full extent without interfering with the flight of the bullets; to prevent balls striking the flag-poles; or the flags themselves interfering with the line of sight.

13. The above arrangement gives sixty targets for long range shooting in one continuous pit. These pits or butts are numbered from right to left I, II, III, IV, V and VI.

14. The first thing is to establish the height of the embankment wall. Taking it for granted that the ground that this ideal range is to be constructed on is level, the height of the main pit for 1000 yards is established with a target bed two feet above the ground. This will make the height of the embankment wall above the level 12 feet. A line is established from the top of this embankment wall to the 700 yard firing point. This gives the height for the different intervening butts. For instance, on the skirmish butt, VI, there is a 900 yard butt, carrying ten targets 100 yards in front of the main pit. This line established allows the carrying of the height of this embankment to 10 feet. The 800 yard embankment in section IV is carried to a height of 8 feet. Sections III, IV, V and VI have a continuous pit containing 17 mid range targets in each section, with an interval of 14 feet between centers, with 29 feet

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from the extreme end of the end of the targets to the dividing lines of the section. The embankment for this long pit is 4 feet 6 inches high.

15. The front of the embankment of this pit is given a slope of one foot in thirty, and is known as a skirmish bank, permitting 32 skirmish groups to be put in each section with a distance of 9 feet between centers. The 500 yard embankment in section II is carried to 3 feet 6 inches. The 500 yard pit has 17 targets with 14 feet between centers, the extreme end of the targets being 29 feet from the dividing line. In order to get the height of the 300 yard butt the line is carried from 25 feet in front of the 800 yard firing point to the 1000 yard butt, which gives a height of 1 foot 6 inches. The 300 yard pit (also the 200 yard pit) has 20 targets with 12 feet between centers, thus allowing 29 feet from the extreme end of the end of the targets to the dividing line. The 200 yard butt, being to one side of the range proper, has an embankment wall 6 feet high. The pistol butt embankment is 4 feet high. These heights are arbitrary, but will be found most satisfactory.

16. Looking from the firing-lines to the targets, the first connecting tunnel is carried down the line separating the pistol and 200 yard ranges, straight to the 200 yard pit. The next tunnel runs from the left of the 200 yard pit to the right of the 300 yard pit. The next tunnel runs from the left of the 300-yard pit to the right of the 500 yard pit. The next from the left of the 500 yard pit to the right of the 600 yard pit. The next from the left of the third section or main 600 yard pit to the right of the 800 yard pit. This continues past the

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right of the 800 yard pit to the 1000 yard pit, right of section IV. The next from the right of the 900 yard pit to the 1000 yard pit, right of section VI. This permits men, entering the tunnel at the firing-line with firing going on at all ranges, to go to any of the pits without being exposed to fire or without necessitating cessation of fire. The firing-lines are all slightly elevated, with a total width of 20 feet, 10 feet either side of the line established. The central 10 feet of this width is level, and slopes to the ground on either side, allowing for drainage.

17. These firing-lines are established as follows: Across the 1000 yard point is established the main firing-line, which, when the butts are used in echelon, permits of firing at all ranges at the same time. Across the line known as the 900 yard firing-line, extending only as far as the right of section I, is established a line to be used for 900 yard shooting when the main or 1000 yard butt is used. Across the line known as the 800 yard firing-line, extending only as far as the right of section I is established a firing-line for 800 yard shooting when the main butt is used. These are known as the long range firing-lines, and are intended for large team or individual matches that require the use of a great number of targets at 800, 900 and 1000 yards. The left sections of these firing-lines, *i. e.*, sections III, IV, V and VI, are to be used when the continuous butt known as the 600 yard butt is thrown open for either mid range or skirmish fire. There is another firing-line established at a point 50 yards beyond the 800 yard firing-line known as the 350 yard skirmish line. This

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covers sections III, IV, V and VI only. Fifty yards beyond this, on the same sections, is another firing-line known as the 300 yard firing-line for either skirmish or slow fire. One hundred yards beyond this, or 200 yards from the 600 yard butt, is another firing-line on sections III, IV, V and VI, known as the 200 yard skirmish or slow fire.

18. In each section on this range a small trench is dug for the bell wire and telephone wire connecting the targets with the firing-lines. Stakes are placed at each firing-line for each target. These stakes have push-buttons in them arranged as shown in the detailed drawing in chapter XIII. On the 800, 900 and 1000 yard firing-lines, where in some cases there are two sets of stakes, one for the mid range 600 yard butt, and the other for the main butt or long range targets, as the distances vary, the long range target stakes being painted black with white numbers. The mid range being white with black numbers.* On the skirmish field there are two sets of stakes on the main firing-line, and the 900 and 800 yard lines, one set to be used when the long 600 yard butt is in operation, the other when the main butt is used. At the 200, 300, 500 and 600 yard firing points on the skirmish field, these distances being established from the targets in the long 600 yard pit, are white stakes with black numbers. At the 200, 300, 350, 400, 500 and 600 yard firing points, at distances established from the line of skirmish figures which are placed 10 feet in front of the line of mid range targets, are

* See paragraph No. 7, page 15, in regard to change in skirmish; also paragraph No. 19, page 23.

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driven red stakes, numbered as the skirmish stakes. These red stakes have no push-buttons.

19. In case the skirmish figures are mounted on the regular target carrier and used in the pit, this extra set of red stakes is unnecessary. In the National Match at Camp Perry, Ohio, 1907 and 1908, the skirmish targets were mounted in this way and the skirmish fire conducted on the mid range butt, giving great satisfaction.*

20. Each pit has its target house for the storage of targets in that pit. There is one flag at the intersection of each section line and every 100 yard line, so that the rifleman does not have to look far to get his wind-flags for direction and force of wind.

21. The uses to which this range can be put are as follows: At one and the same time, from the same firing point, firing can be conducted on twenty 200 yard targets, twenty 300 yard targets, seventeen 500 yard targets, seventeen 600 yard targets, ten 800 yard targets, ten 900 yard targets and ten 1000 yard targets, this being a splendid arrangement for team practice where different teams desire to practice at different ranges. In case the 300 yard range is not being used, firing can be conducted from there at 1000 yards. The same can be said of 500 or 800 or 900 yard butts. Or if it is desired to conduct practice on half the range at 1000 yards, and the other half at 600 yards, it can be done. By closing the fourth, fifth and sixth sections from long range firing, skirmishing can be conducted in section

* As the present conditions of the National Match call for the use of the *B* target for skirmish, there is a chance that figures will be done away with. If such is the case, the extra stakes for skirmish will be unnecessary.

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VI without danger of being hit from the mid range or long range firing conducted in section III. In fact, with expert marksmen, skirmish practice can be conducted in section VI while long range practice is going on in section V.

22. For large team matches or practice the sixty-eight mid or short range targets in the long 600 yard butt can be used at 200 yards slow or rapid fire, at 500 yards slow or rapid fire, and also at 600 yards. The long range match can be conducted from the firing-lines at 800, 900 and 1000 yards, using sixty targets.

23. Sections III, IV, V and VI can be used for skirmish groups to be fired on, allowing ten teams of twelve men each to make a skirmish run at the same time.* The fact is, this range is capable of almost any combination of uses to which it may be desirable to put it.

Range with Continuous Firing-Line and Butts in Echelon.

24. A departure from the ideal range is shown in plate II. In this case there is a common firing-line and the butts are in echelon. This is a good type of range for organizations to use where it is desired that practice be conducted at numerous ranges at the same time, and the question of expense has to be considered. This type of range is not well suited for large matches where numbers of men are required to shoot at the same range at the same time, unless built on a much larger scale.

* See paragraphs No. 7, page 15, and No. 19, page 23. When the regular pit is used only 68 targets are available, therefore but five teams can run at once.

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It is an excellent type, however, for qualification and re-entry matches. In this case, it is not necessary to establish a line for determining the height of the butts. The only rule to follow is not to have the short or the mid range embankment walls higher than six feet and the long range higher than twelve feet. On this range, firing can be conducted only from the one firing-line. If the ground is of sufficient size, and a large range is contemplated, this type is perhaps the best, in which case sixty targets would be put in each pit.

Range with a Continuous Butt Where the Firing-Lines are in Echelon. (See plate III.)

25. This is another departure from the model range in which case there is a common butt. The embankment wall in this case should be not over six feet in height owing to the fact of its having to be used for 200 yard shooting. This type of range can readily be used for a large team match or when a number of targets are desired at any one range, but it has the disadvantage that it cannot be used at different ranges at the same time without danger to those firing at the shorter range, unless the targets used are so far apart that only about one-half can be used.

26. There are special occasions where either of the above departures is advisable, and it sometimes is necessary to arrange the butts in echelon because the classes of firing are mainly confined to qualifications.

27. It may be, owing to local conditions, that no one of the above types would be suitable, but as this would be an exceptional case, it should be handled as such.

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CHAPTER III.

Selection of a Site.

28. The two highly essential considerations in the selection of a site are, first, accessibility; second, safety.

29. The element of accessibility is the prime consideration in the selection of a site for a rifle range. In this respect it must be remembered that safety is absolutely necessary, and the more accessible a spot, the more likelihood there is of its being unsafe. Therefore, safety is always to be considered as absolutely essential, yet safe sites can be easily found that are so inaccessible as to preclude any possibility of their selection. In making a survey of the various sites that may be offered, it must be remembered that the country adjacent to the range should not be subject to the slightest danger from the wildest accidental shot; at the same time, it is recognized that a sufficient area to insure this element of safety may not be secured except at prohibitive cost. Therefore, in sections of the country more or less thickly populated, where the economy of acreage must be regarded, a site having a background of water or of sufficiently high hills would naturally be selected, other considerations being equal. It may also be possible to select a site beyond which may lie marsh land or untraversed woodland.

30. Local conditions will almost entirely govern the final selection of a range. Where none of the foregoing natural advantages can be secured, it becomes necessary

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to take proper preventive measures such as the erection of sufficiently high backstops, and, even in some cases, the building of high baffle-shields or screens placed to the sides of the range and at right angles to the backstops.

31. Another general consideration is the desirability of having the targets lie in a northerly direction from the firing-lines.

32. In the topographical survey the following details should be given their true weight: The model range should be located on ground as level as possible, assuming that there is natural drainage or that artificial drainage may be taken care of. Excessive variations in contours should be, if possible, avoided; although other natural advantages would permit the adoption of land having a gently rolling surface. No attempt should be made to secure protection from prevailing winds. If possible, avoid selecting rocky land or land where large boulders, not readily removed, may increase the danger of ricochet shots. It will also be remembered that low-lying land with a poor water-shed, marshy or swampy, precludes the construction of pits; but where land of this character presents other desirable features the targets may be protected by butts on cribs. Constructive details, embodying the above features, are shown in the chapters assigned to those subjects.

33. The following is an example of what could be done with a stretch of ground that had no apparent topographical advantages beyond its accessibility and safety.

34. Referring to plate IV it will be noticed that the

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piece of land selected is adjacent a railroad with a station platform. The sparsely settled country provides the invaluable element of safety; and what few roads there are, are but little traveled. The contour of the land adjacent the creek did not indicate a promising site, but on account of the two important factors of accessibility and safety, it was decided to use this spot for the construction of the rifle range.

35. The location of the creek made it necessary to have a stretch of at least 400 yards in the direction of the line of fire that could be used for the different firing-lines, this being necessary on account of skirmishing. With the firing-lines on the railroad side of the creek, it was found that the required land could be procured west of the road and lying between the railroad and the creek. This made it desirable to place the butts on the opposite side of the creek from the firing-lines. This plan of the range permitted the minimum amount of earth filling. On referring to the profile of this ground, it will be noticed that the dotted lines show the original contour of the land. In this case the amount of filling necessary was done without any great cartage of soil, as the quantity of soil cut away was about equal to that required to fill. Two retaining walls of cement were put up on either side of the creek to hold this soil in place. The range as finished with backstop was well worth the amount of time and money spent on it, and gave a very satisfactory range for a small organization.

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CHAPTER IV.

Laying Out Firing-Lines and Pits.

36. It will be noticed from the preceding chapters that in order to have an ideal range an absolutely level piece of ground is desirable, of sufficient size to permit planning a range of this description. Where level ground cannot be secured one of the alternative plans must be used. The topography of the land will greatly influence the plan adopted, but, for instance, where slight variations of the contour will permit a better scheme and method of construction, where the expense is not too great, it is advisable to get as near the ideal range as possible. By referring to the last chapter it will be seen how a piece of land can be laid out that is far from level. Of course, this is an exceptional case. The question of drainage should but slightly influence the positions of the firing-lines or butts. The location of butts or pits is influenced by the amount of excavation necessary, depending on the type of range. Ordinarily, they are so disposed that the butts are of proper height to protect the pits, without exceeding a height of 12 feet, or in the case of short range, 6 feet. (See chapter II, plates I, II and III.)

37. In laying out the position of the skirmish field it is necessary that the 400 yards immediately in front of the 600 yard firing point be level or sloping slightly toward the target. The space from the 200 yard firing point down to the targets may be depressed or in marsh

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land or even under water, provided that the stretch of land for the line of targets is in such position that it can be seen distinctly from the firing-lines of the skirmish field. In laying out the firing-lines and target pits it is highly desirable that all possibility of cross fire be precluded.

38. Endeavor to so plan a range that all firing may be from a common line, the target pits being established in echelon. If this is not economically practicable, then a compromise may be effected where the firing-lines and pits are both in echelon. Local conditions may preclude either of these plans being adopted, in which case the firing-lines are in echelon and the butts are on one line. This plan may be seen by referring to plate III in chapter II.

39. Local conditions may permit a desirable variation from any of the foregoing plans whereby the skirmish field may be entirely separate and apart from the range proper. Should a separate skirmish field be used and be adjacent the range, it should be next to the long range with the 600 yard firing-line common to the 1000 yard line of said long range.

40. For the short range targets allow 12 feet between centers of the targets. For mid range allow 14 feet, and for long range allow 24 feet. Where the length of the firing-line is less than or exceeds the length of the line of targets it is permissible, although not desirable, to vary the distances between stakes at the firing points accordingly. Allow at least 30 feet normal to the line of fire between the ends of target butts at the extremities of each section of range, whether the pits are in line

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or in echelon, as will be noted in paragraph 10, chapter II. The firing-lines should be elevated as shown on detail 1, plate V.

41. The length of the pit and embankment wall depends entirely on the number of targets to be in the pit, but at least 6 feet should be allowed at the ends of the pits beyond the end targets for the safeguarding of markers in the pits. The ends of the embankment wall should not be perpendicular, but have a slight slope.

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CHAPTER V.

Grading the Range and Firing-Lines.

42. As little grading, cutting and filling as possible should be done, just sufficient to give an unobstructed view of the targets from all points, to provide proper drainage and sanitation, and, on the skirmish field, to give clear running space.

43. All firing-lines should be so located and built that the targets and a 12 inch space below them can be plainly seen in the prone position from any part of the firing-line. On many ranges the ground is so uneven that the targets cannot be plainly seen. To remedy this the firing-lines should be banked as shown on plate V, page 33; this slight elevation also means economy in the matter of cutting the grass on the range and provides for drainage. The entire firing-line should be sodded or sown with short, thick-growing grass-seed. The section of firing-line shown on plate V, detail 1, page 33, is typical. This firing-line is 20 feet in depth, 10 feet of the interior section being 12 inches high, the front and rear sloping 5 feet to the ground level. The necessary earth for this work can be taken from the ground in front and in rear of the established line. It is advised that on the skirmish field the firing-points be also elevated.

44. Where it is necessary to construct a firing-line in the side of a hill, allow a sufficient width for a drain in rear of the firing-line, which will insure the ground being dry, as shown on plate V, detail 2, page 33,

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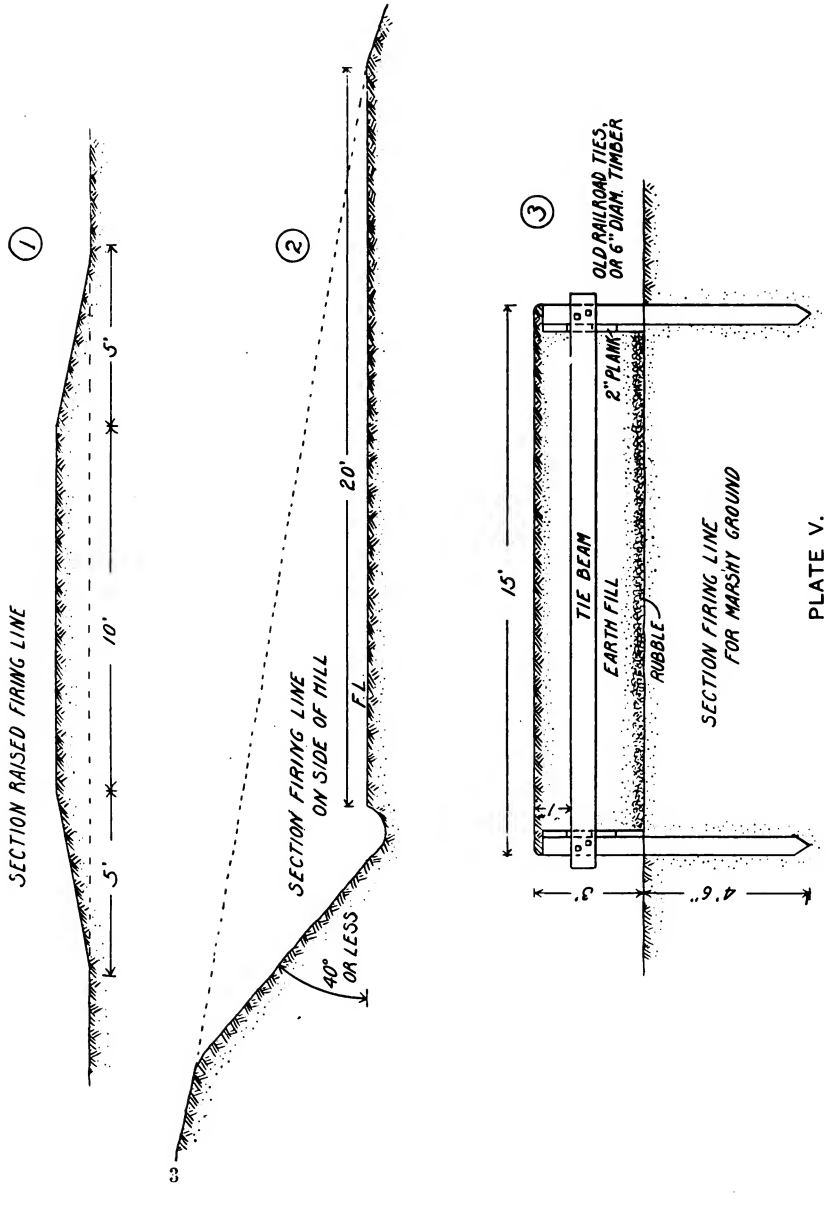

PLATE V.

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wherein the total horizontal level developed is 20 feet, thus providing ample passage-way in rear of the actual firing-line.

45. Where firing-lines are to be located in marsh-land or on soft or damp ground, it becomes necessary to build up embankments, possibly to a height of 3 feet or more, in which case a coil should be built by sinking two lines 15 feet apart of railroad ties, or 6 inch posts, about 7 feet long, 4 feet in the ground, parallel to the firing-line, the piles spaced about 5 feet, and shoving of 2 inch undressed planking spiked to the insides of lines of piles or posts. The two lines of piles are tied with planks across opposite posts, the bottom covered preferably with rubble or broken stone or gravel, then filled with dry earth and sodded.

46. Where the firing-line embankment must be higher, heavier material must be used, and the piles or posts sunk proportionately in the ground, with possibly a middle layer of tie-planks. It will be noted that provision for access to the various firing-line embankments must be made by building similar approach embankments to one or both ends of the firing-lines.

47. On ordinary, dry ground, local conditions of levels, etc., may necessitate firing-lines on embankments higher than that shown on plate V, detail 1, in which case similar construction as above is recommended except that the piles or posts need not be so long or sunk so deeply into the ground.

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CHAPTER VI.

Drainage.

48. The subject of drainage of the rifle range cannot be covered except in a general way.

49. The proposition of mechanical drainage can be dismissed as being impractical from the standpoint of expense, except under special or extraordinary conditions. By mechanical drainage is meant power actuated pumps of various types, syphons or other like means of removing collected water. This will not be treated here, as each separate case will require special handling, but the general matter of natural drainage of pits and firing-lines can be touched upon.

50. Chapter III, on the selection of sites for rifle ranges, deals with some of the things that have to be considered in regard to drainage. The places necessary to keep free from water are the target pits, the firing-lines and the skirmish field. Other parts of the range between firing-lines need not necessarily be drained to as great an extent as the above-mentioned, yet, at the same time, it is inadvisable to allow any contour to remain that will collect water. The pits proper are drained with trenches as shown on plates VI, VII, VIII, pages 42, 44 and 46. These drains are of sufficient size to insure the bottom of the pit being kept clear of water, except under extraordinary circumstances. The construction of these drains, as well as the cess-pools, is treated in chapter VI on pit construction.

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51. In chapter IV on laying out firing-lines and pits, it stated that all firing-lines should preferably be elevated. This, of course, does away with the necessity of special drainage for the firing-line, but where a firing-line is located in the side of a hill (see plate VI, detail 2, page 42) a small drain should be placed immediately in rear of the firing point itself, and if the slope of the hill continues to some distance in rear of the firing-line, it is also well to put a catch drain of sufficient size to carry off water above and in rear of the firing-line.

52. The draining of the ground of the skirmish field should be done by trenches running around the edge of the field. This will prevent water coming from other parts of the range which might tend, owing to the contour of the land, to collect on the skirmish field. If these are not sufficient and there are spots in the skirmish field that collect water, these spots should be levelled off. It is not advisable, however, to place small trenches or drains on the surface of the skirmish field, as they might cause some serious accidents to men skirmishing.

53. The firing-lines on the skirmish field being elevated the same as for other parts of the range do not require special care.

54. In draining the surface of other parts of the range where it becomes necessary, small trenches can be run from the low parts of ground to the places that would indicate the natural flow of water. If the range receives water from some natural water-shed it is well to place a catch drain in such manner as to protect it from such. Pits should be protected by catch drains from any water that might tend to collect at those points.

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55. A rather expensive way of draining the surface of a range is by building what are known as sub-drains. These are simply excavations from 6 to 8 feet deep, varying in size according to the amount of ground to be drained. The diameter of these holes to be about 10 feet. They are then filled with rubble or broken stone and covered with about a foot of earth and sod.

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CHAPTER VII.

Targets.

56. Targets are of two general classes, wood and metal. The wooden target is at its best but a makeshift. It cannot be considered in any way permanent, and while its initial cost is perhaps a few dollars cheaper, before it has been used one season its cost has probably been increased by reason of repairs, to much more than the cost of metal targets.

57. There are numbers of types of wooden targets. In fact, nearly all of the older ranges have tried different forms, but none have proved thoroughly satisfactory. These are now being replaced by some form of metal target. The Government supplies several wooden targets, only one of which is worth considering.

58. The sliding target (Brinton), is fully described in the Firing Regulations for Small Arms 1904.

59. There are several other forms of wooden targets besides the sliding, but they all have their disadvantages.

Revolving (Laidley) Target, Both Vertical and Horizontal.

60. This target has the disadvantage of requiring a very wide pit to work it in, and at least two men to run it. Then on account of being so far from the embankment, markers pasting shot holes are in danger of being hit. Again, the target in the pit has its surface away from the marker, necessitating his getting in rear of the target in order to paste or spot a shot.

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61. While the horizontal axis (Laidley) target of this type does not require any more length of pit than the sliding target, the vertical axis (Laidley) needs double the amount.

Revolving (Texas) Target.

62. This target, while safer for the marker than the above, occupies just double the length of pit that the sliding target does. It can be used in a regular pit. It has the disadvantage of reversing the position of shots from the markers' standpoint, leading to confusion in case of challenge or re-marking. In fact, all revolving targets require to be marked before being drawn into the pit.

63. Rolling and swinging targets, while not requiring wider pits than the sliding, at the same time need double the length of pit. They are also troublesome to run.

64. Of all wooden targets the sliding is the only one that can be used with any degree of satisfaction.

Metal Targets.

65. Metal targets have the advantage that they can take the A, B, or C target on the same carrier, although in pits that are used exclusively for short range work they are sometimes made in a pony size to use the A target.

66. There are a few forms of metal, all of them better than the wooden. The two best known are the "National" and "Aiken."

67. There is great similarity in these two targets. They possess great rigidity and ease of manipulation.

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The sliding carriers have rollers for running gear. On the National Carrier these rollers run on rods, while on the Aiken they run on angle iron. Both these target carriers are made with treadle starters, which greatly eases the manipulation of the target, this treadle being worked by the foot of the marker. Both targets can be used in the same pit as the Government sliding target, and occupy about the same space.

68. All plates for pit construction are dimensioned for the Government sliding or one of these metal targets.

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CHAPTER VIII.

Construction of Pits and Butts.

69. It is obvious that standard plans and specifications for the construction of pits and butts cannot hold true for all sections of the country, so there will be presented general data to meet the widely varying local conditions. In some sections of the country where timber is plentiful and the character of the earth or clay of that section is such that wood construction will last a reasonable length of time, it would be unwise to recommend anything other than timber, since the initial cost of installation, as well as the subsequent maintenance, would undoubtedly be very low. On the other hand there are sections where the rocky nature of the land or the proximity to quarries or cheapness of stone or cement delivered would make it advisable to recommend masonry or cement work. These are matters for local judgment.

70. By referring to plate VI, detail 1, page 42, it will be noted that there are four important components to all pits: the embankment wall, the tread, the target bed and the drain. The construction of the pit depends upon the type of range, the nature of the soil, etc.

71. There are two general classes, surface and sunken pits.

72. In the surface pit the target bed is on or above the level of the ground and the sunken pit has the target bed below the ground level. In building the surface pit

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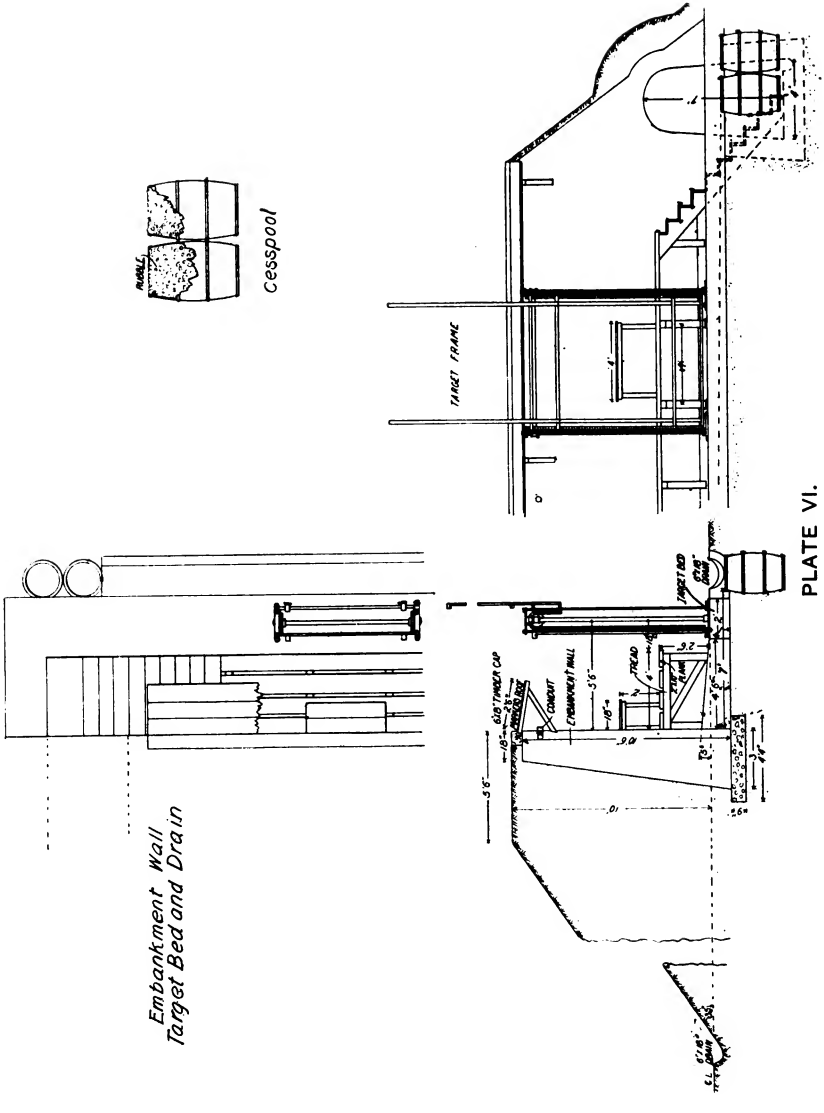

PLATE VI.

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the first thing erected is the embankment wall which should be 10 feet above the level of the target bed including the timber cap which is 6 inches by 8 inches. This wall may be made of concrete, brick, masonry, metal, timber or composite construction, dependent upon the locality and comparative costs of materials. The target bed is then laid 4 feet 6 inches from the embankment wall, two feet wide, preferably of cement, where metal target frames are used, that the targets may be properly anchor-bolted. Where the Government sliding target of wood, or some similar type, is used, a cement bed is not essential, although any other construction should not be regarded as desirable for a permanent range.

73. The tread, of mill construction, is next laid, being 4 feet wide and 2 feet 6 inches high, and against the embankment wall and opposite each target frame should be built a wooden bench 18 inches wide by 4 feet long by 2 feet high, as detailed on plate VI, page 42, this tread and bench being for the use and service of the markers. While it is true that many ranges have been and are being constructed having target pits built with cement treads, it is recommended that wood treads be built for the reason that the first cost is less and they are always drier and easier on the feet of the markers. A shelter roof about 2 feet 6 inches wide and pitched at an angle of about 20 degrees should be built along the entire rear surface of the embankment wall, as shown on plate VI. Back of the target pit the excavation is made for a drain about 6 inches deep with a maximum chord of 18 inches, the greatest height being near the

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Sunken Pit Rear Wall Natural Slope.
——For Sandy Soil——

PLATE VII.

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center of the pit having a normal flood slope to drain barrels filled with rocks or broken stone, the number of these barrels and drainage capacity depending upon the absorptive qualities of the soil.

74. In front of the embankment wall earth should be filled in to the top of the timber cap, carried out horizontally so that the crest of the embankment is about 5 feet 6 inches from the rear face of the timber cap and the slope of the embankment carried down at an angle of about 35 degrees, at the base of which slope there should be a drain not less than 6 inches deep and 18 inches wide.

75. The sunken pit (see plates VII and VIII, pages 44 and 46) brings in the question of excavation. There is no standard depth to which a pit should be sunk, but the same rules follow for all styles. As will be noted on plate I (page 18), this depth varies in order to allow of firing at all ranges. The excavation should first be made, allowing sufficient room for the embankment wall and drain. The embankment wall should then be erected, timber-capped as in the case of the surface pit. In front of the embankment wall, earth should be filled in to the top of the timber cap the same as in the surface pit, the drain constructed and the earth fill sod-covered. The earth in the rear of the pit should be kept in position by a retaining wall of the same material as the embankment wall (see plate VII, page 44), unless the soil is of a very porous nature, in which case, in excavating, the rear wall, instead of being perpendicular, may fall away with the natural slope of 35 degrees (see plate VIII). This, however, can only be

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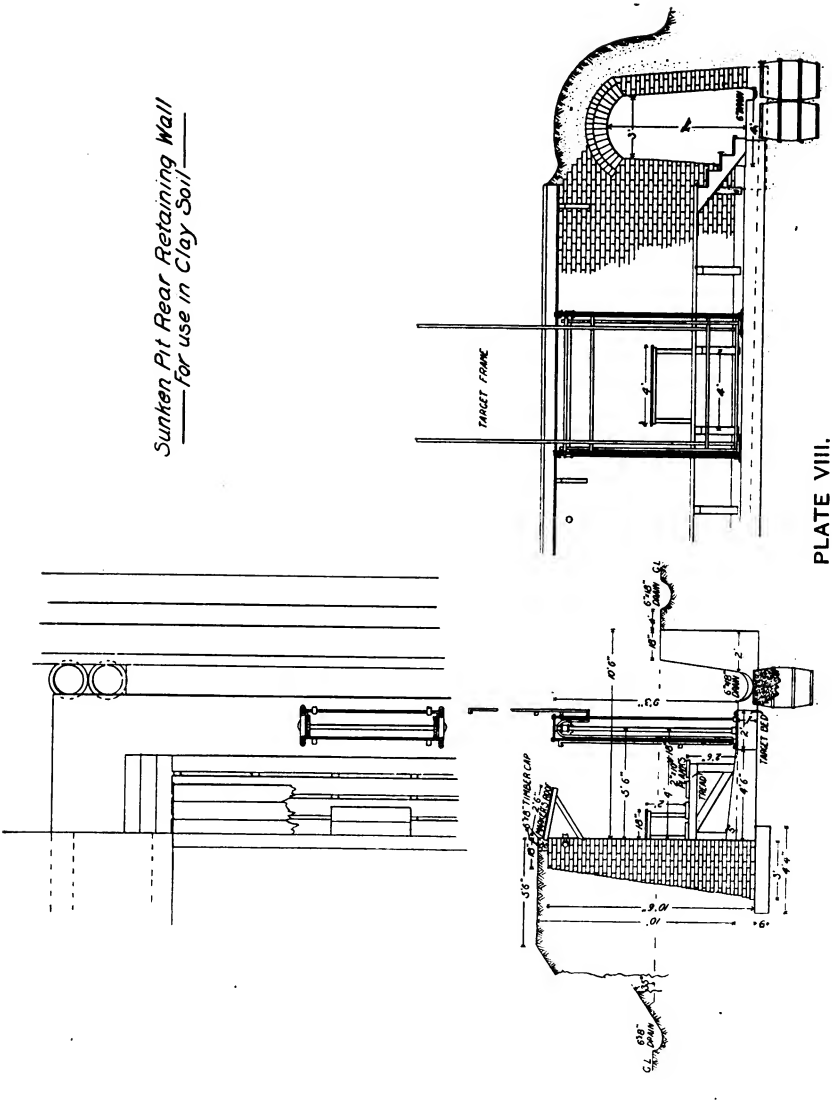

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used in case the soil is porous, as the additional width of the top of the pit due to this style of construction, requires either a very large drain or porous soil to properly drain it.

76. The target bed and tread are constructed the same as for a surface pit. The size of the drain for this type of pit should be determined by the depth of the pit and the nature of the soil. For ordinary clay it should be about 18 inches wide, starting with a depth of 12 inches at one end with a normal flood slope to the other end, finishing with a cess-pool formed of two hogsheads sunk in the ground side by side and filled with rubble. In the case of very long pits it is advisable to put a sufficient number of cess-pools to carry off the water that would accumulate during a rain storm.

Embankment Walls.

77. The embankment walls are constructed of different materials: cement, brick, masonry and wood.

78. The dimensions of the first three are the same.

79. Figure I, plate IX, page 49, shows the cement wall. Figure II, the brick wall and figure III, the masonry.

80. The foundation stone is first laid 4 feet 4 inches wide and 9 inches thick. The wall is then built, 10 feet 6 inches high measured from the upper side of the foundation stone, with a thickness of 3 feet at the bottom and 18 inches at the top. The inner face of the wall is vertical; the opposite face, inclined. It is very important that the base of the wall be put below the frost line, otherwise the frost will have a tendency to

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heave the wall, this depth depending on local conditions.*

81. While embankment wall is in course of construction sections of iron pipe, 1 inch in diameter and 6 inches long, should be embedded vertically flush with the top of the wall, 3 feet apart, and 4 inches back from the face of the wall. At the same time iron or steel armored conduit for telephone and push-button wires should be set in the embankment wall with outlet boxes or elbows spaced at desired intervals, preferably between each two targets, the conduit to be not less than 1 inch and to be as much larger as would contain the required wires depending on the number of targets in the pits. The conduit should be embedded at least 3 inches from the surface of the wall and about 18 inches below the top of the wall. (See plates VI, VII, VIII, pages 42, 44 and 46.) The timber cap, 6 inches by 8 inches, is fastened to the top of the wall with a 6 inch surface continuing the inner face of the wall. This is fastened with wooden tree nails driven through holes in the timber cap into the iron pipes.

82. These walls are so placed in the ground that, including the timber cap, they will be 10 feet above the target bed level.

*With the object of uniformity in view, the cement, masonry and brick walls are given the same dimensions. This is correct so far as unsupported cement is concerned. If, however, it is desired to use reinforced concrete, the wall can be made much thinner, in which case, however, the wall has to be tied in the same manner as the wooden wall shown on Plate IX, page 49. This wall costs about the same as the plain concrete.

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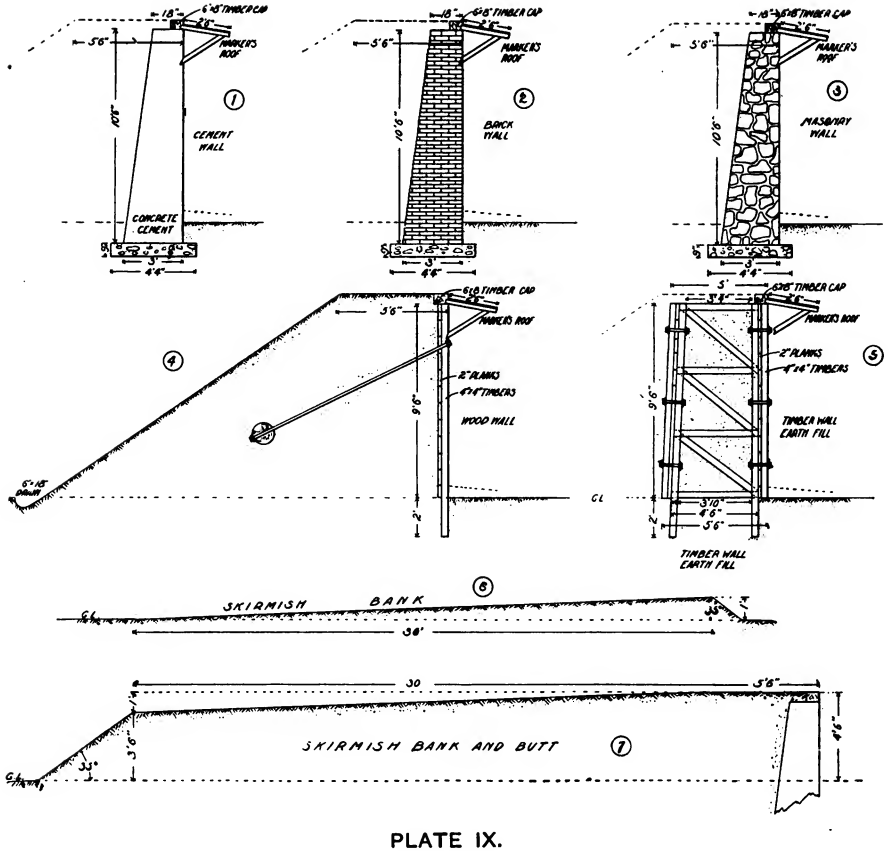

PLATE IX.

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83. Wooden embankment walls are constructed in two ways: single or double. (Plate IX, page 49, figures 4 and 5.)

84. The single wall is built of 2 inch planks nailed to 4 inch by 4 inch joists. These joists are planted firmly 2 feet in the ground in a vertical position. They should project 9 feet 6 inches above the target bed level, and be placed at 3 feet intervals. The planks are nailed to these joists on the side on which the earth fill rests. The conduit is carried along on the inner side of this wall, with outlet boxes placed between every two targets. The timber cap is tree-nailed to the top of this wall (see plate IX, page 49, No. 4). Iron or steel tie rods connect every other joist with a log or dead man sunk in the earth fill.

85. All these embankment walls have earth fill in front of them. This fill is flush with the top of the timber cap and measures 5 feet 6 inches from the crest of embankment to face of the wall. The fill falls away from the crest with a natural slope to the ground level.

86. It is highly desirable that the slope and top of the earth embankment be heavily sodded or sown with a short, thick-growing grass-seed.

87. Another type of embankment is shown on plate IX, No. 5, page 49. This is formed of two fences firmly braced together. Earth is used as filling. Each of these fences consists of 4 inch by 4 inch joist placed at 5 foot intervals. These joists are firmly planted 2 feet in the ground. Those for the rear fence in a vertical position, those for the front fence slightly off the vertical. These two lines of joists are placed about 3 feet

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10 inches apart at the target bed level and 3 feet 4 inches apart at the top, which is carried to a height of 9 feet 6 inches above the target bed level. The two lines of joists are firmly braced together as shown in the cut. Two-inch planking is then nailed on the outside of these joists. Other 4 inch by 4 inch joists are then vertically placed on the outside of this planking, each joist being fastened to a corresponding interior joist with three bolts. The timber cap is fastened to the top of the rear fence. The conduit is run along on the interior joists of the rear fence, with outlet boxes between each two targets. The space between the two fences is then filled with earth flush with the top of the timber cap. This top should be sodded.

88. Earth can be filled in front of this wall to take the general form of the regular embankments, but is not necessary unless the front wall be greatly damaged from rifle fire.

89. If no earth fill is placed in front it will be found advisable to cover bolt heads on the outside of front fence with blocks of wood to avoid any possible danger of ricochets.

90. This last type of embankment wall is useful for erection on cribs as it weighs less than the other types.

Metal Embankment Wall.

91. It is just as well to mention another type of embankment wall. That is the metal. This style, while it has the advantage of being easy to install, has the great disadvantage of causing much discomfort to markers on warm days. This of itself is enough to condemn it.

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Where used, however, the manufacturers have special methods of installing, but the general form of the embankment and pit remains the same.

Target Beds.

92. The special styles of target beds required for different targets are treated in chapter IX; they are treated here more as regards position than construction.

93. The target bed proper should be placed 4 feet 6 inches from the face of the embankment wall. If the bed is of cement or wood, it should be so placed that its upper surface will be 10 feet below the line of the top of the embankment.

94. The space between the target bed and the embankment wall can be earth or cement. It should be flush with the top of the target bed, with a slight rise toward the embankment wall. If made of cement this can be made at the same time the target bed is laid, being in fact a part of the bed proper.

95. Target beds of cement should be at least 12 inches deep and 2 feet wide, this being greatly strengthened by the cement fill between the embankment wall and the bed. Target beds of cement should run the full length of the pit. (See plate XIII, No. 1.)

96. Wooden target beds should be anchored firmly, using iron plates 6 inches by 12 inches, $\frac{1}{4}$ inch thick with 1 inch rods through the center as anchors. Two of these anchors being fastened at each end of the bed, which when made of wood is about 8 feet long. (See plate XIII, No. 2.)

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97. If cheapness is an object, and the Government sliding or Brinton target is used, neither of these types is necessary, but the earth can be levelled off the same as the cement bed, and the target rested on this. This bed is not recommended, neither is the target. (See chapter VII.)

98. The drain should be preferably made of cement. The best drain is in the form of an arc, the depth and width depending on the nature of the soil. A minimum size of drain would be with a chord of 18 inches (the width) and a depth of 6 inches, this dimension being established at the highest point of the drain, the bottom of the drain having a normal flood slope (or 4 inches in 100 feet). The width of the drain not to increase. The length of each section of drain not to exceed 300 feet as it is not advisable to carry the drain below the bottom of the target bed, and with the normal slope this would be the case. At the end of each section of drain, cess-pools are sunk. (See plate VI, No. 3.) These are best made of hogsheads sunk in the ground filled with broken stones. Two hogsheads side by side will carry off all water that will drain from the usual pit, except under abnormal conditions. In a long pit, the drain is best formed by having hogsheads at regular intervals. In the long pit, as shown in plates I and III, these would be at the dividing lines between sections.

99. Of course, in pit construction where the pit itself runs across ground with a slight slope, it may not be necessary to install cess-pools. The drain will carry all water to one end of the pit where it can be run off

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onto the ground, or into a larger drain used to carry water off the range itself. This of course would be an unusual case. It is not wise to ever use a deeper drain than 18 inches, as it becomes too expensive to construct. The cement drain should be heavy enough not to crack easily.

100. Where cement target beds are used, these drains should be constructed as a part of the bed. Under no circumstances should cement beds be left without cement drains on account of the danger of their being undermined.

101. Wooden target beds cannot of course be considered as permanent, but, if used, cement drains are recommended, as wooden beds depend on their anchors for support.

102. A mere cut or trench in the earth will carry off the water, but the repairs necessary on a trench of this sort soon discount any advantage of cheapness in initial cost.

103. In pits with target beds elevated above the ground line, no drains are necessary, but it is advisable to shape the rear of the target bed so as to prevent the washing away of the soil around it.

Rear Retaining Walls for Sunken Pits.

104. Sunken target pits require a rear wall, unless the soil is of a sandy nature, when the natural slope of the earth will suffice. This rear wall should be built of the same material as the embankment wall. The size depends on the depth of the target bed below the ground line. The general form of construction is shown in

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plate VII. As no part of the structure of the pit depends on this wall for support, its dimensions can be readily determined by local conditions.

105. It is well to put a small catch drain on the ground just in rear of this wall, as a precaution against the water running over the top of it.

106. The tread should be made of wood, and should run the full length of the pit, as it is not only used as a platform for markers, but also as a walk. It is 4 feet wide and 2 feet 6 inches high. This requires no special explanation, as all detail can be seen in plate VI. Wood is the only material recommended for a tread. The markers' seat should be made so it can be folded against the embankment wall. Each seat should be 18 inches wide, 4 feet long and 2 feet high. It is also advisable to place a shelf at a convenient height opposite each interval between targets to hold pasters and other small articles.

107. The markers' shelter roof, also made of wood, while not absolutely necessary, is at the same time recommended. It runs the full length of the pit, is 2 feet 6 inches wide with slope of about 20 degrees. It is fastened at one edge to the timber cap, and is braced from underneath by props let into recesses in the embankment wall. If the wooden wall is used, these props are nailed to the 4 inch by 4 inch joists on rear of wall.

108. Target houses, while generally placed in pits, are not properly a part of the same, and will be treated in chapter XII.

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Skirmish Embankments.

109. With the system of skirmish figures in use at present,* in order to get the best results, a skirmish or ricochet bank is necessary.

110. This consists of a bank 30 feet wide (see plate X, No. 1, page 57), with a height of 1 foot at the rear edge sloping to nothing at the front edge.

111. No. 2, of the same, shows a skirmish bank built in front of the usual butt. This is used in such a case as is shown on plate I, where the 600 yard butt is put to a double use. The bank in this instance has the same angle of slope as No. 1, plate X, but this slope begins from the crest of the embankment to a point 30 feet in front of that.

112. As the skirmish figures stand on the bank, being held in position by a metal brace, the feet of the target sunk in the ground, no provision is made for their installation. Some ranges, however, have pieces of iron pipe, flattened to receive the feet of target, vertically sunk in bank, flush with the surface, at whatever place on the bank the targets are placed.

* See ¶'s 7, 19, in regard to skirmish. It is probable that skirmish embankments will not be used at all in a year or so. At the present time there is considerable discussion as to the advisability of using the present system of silhouette figures. The chances are that in the near future the skirmish target will be generally used on a *B* frame or some modificaton of this type. As this will be used in the usual pit, it will do away with the necessity for a skirmish bank.

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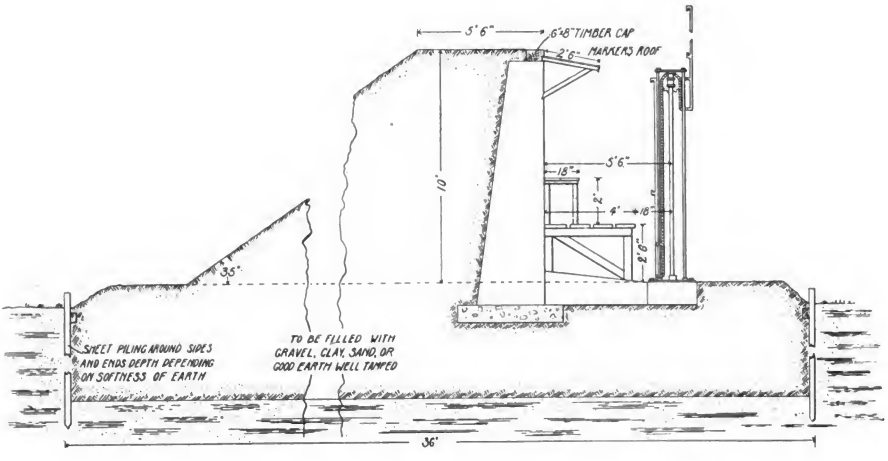

FIG. 1.

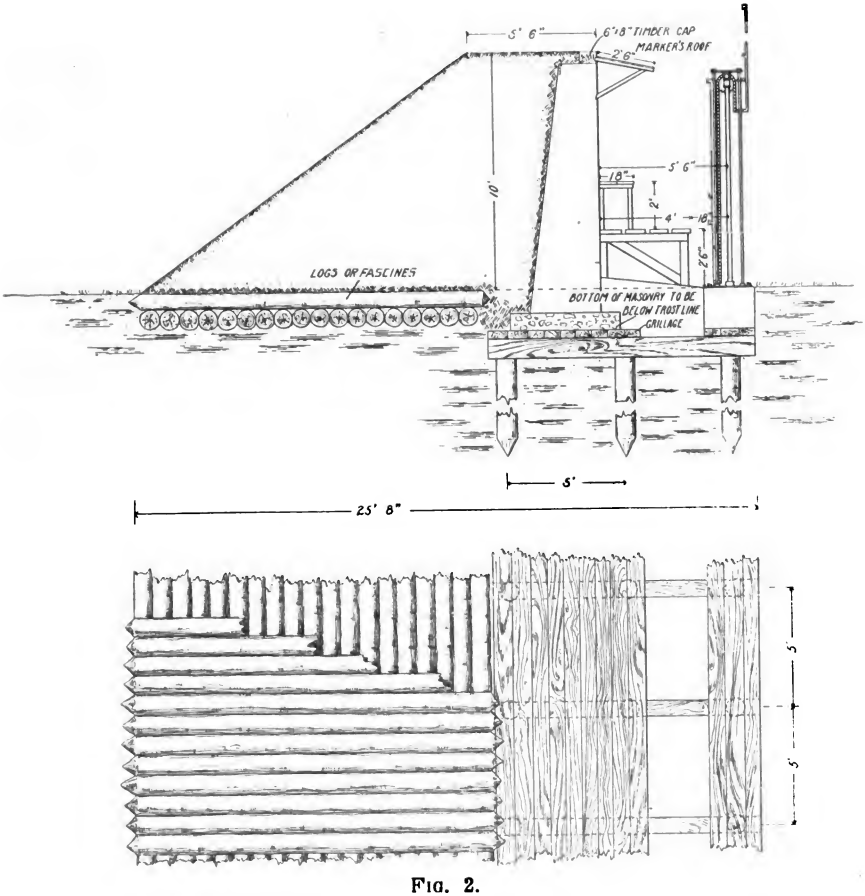

FIG. 2.

PLATE X.

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Butts on Cribs.

113. Butts are sometimes located in marshes or some other soft soil. These are naturally of the surface type.

114. The foundation for these should be made by first forming a crib or sinking piles, putting in earth fill and then starting the pit construction as for surface pits.

115. Four types of crib are shown.

116. The first, plate X, page 57, is for marshy ground which has a solid bottom within a few feet of the surface.

117. This type shows a line of sheet piling on each side and on the ends of target butt, driven down into solid ground. Between the two lines of piling the marshy ground is excavated and solid earth is filled in; this filling may be of any good, solid earth which can be conveniently obtained, better sand or gravel; filling to be put down in layers well tamped. The sheet piling should be made of planks about 3 inches thick, pointed and driven down with a maul into solid ground. We have shown a timber running along the inside face of the sheet piling to keep the piling in line. It will be noticed that no particular depth has been given for this filling or sheet piling as this would depend upon the depth at which solid ground would be found.

118. The other types are for marshy ground where solid bottom cannot be at convenient depth. However, the first of these propositions (second type) may be used with short piles where solid material is encountered a few feet below the surface.

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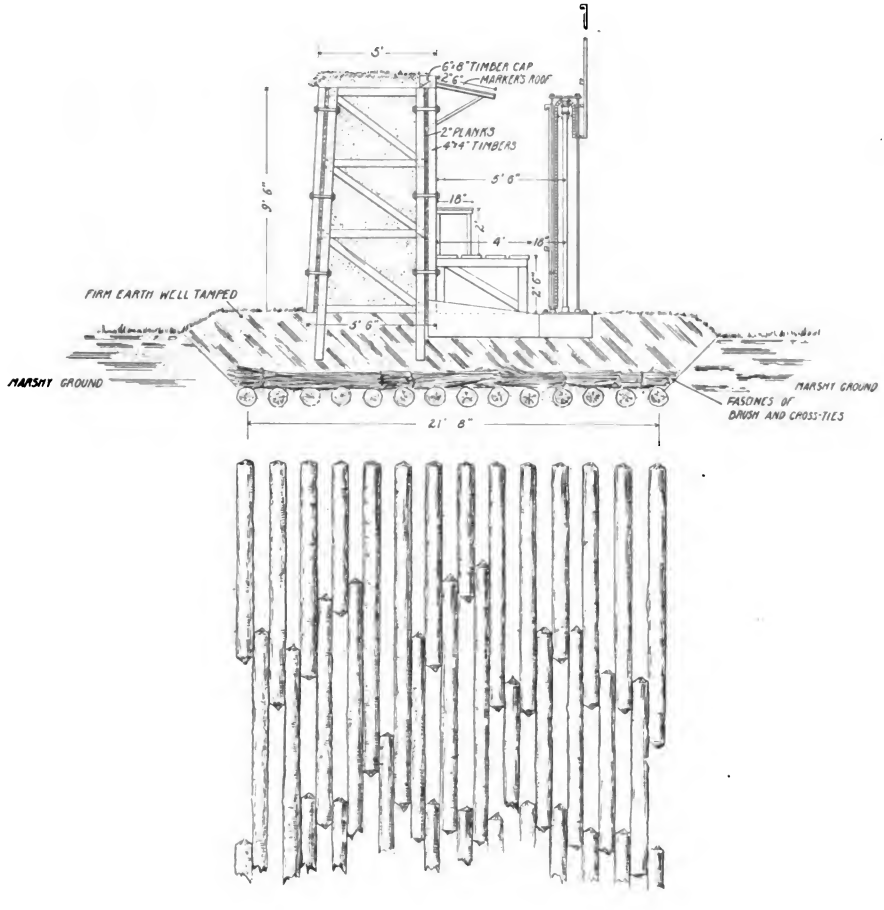

PLATE XI.

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119. Where the amount of excavation and filling required for the first type is too great, the second may be used. This proposition shows piles of about 10 inches or 12 inches diameter driven down to a solid bearing, or deep enough to sustain the load required, with a heavy maul where piles are short or by a suitable pile driver. Beneath the masonry and target proper these piles are spaced about 5 feet between centers as shown in plan view and are capped with a timber about 10 inches by 10 inches. A grillage of 4 inch planks or equivalent spiked on these caps as shown is beneath the masonry of the butt throughout its full length. To carry the earth-filling of the butt, a double layer of logs, fascines or old cross ties are laid as shown imbedded into the marsh.

120. The third type (plate XI, page 59) is for very marshy ground and, while not so satisfactory, is more economical than the first two. Here a shallow excavation is made the full length of the butt and logs laid lengthwise as shown in plan view; on top of these logs crosswise are laid brush, old cross ties, or fascines sufficient to prevent the solid earth filling from working through. This filling is to be well tamped to form a good bed for the target butt and target.

121. The fourth type (plate XII, page 61) is similar to the third, except that logs are laid crosswise and without any space between them; ties or planks are spiked directly to them to make a stiffer platform on which to lay the solid earth. This method gives a closer and more rigid bottom on which to carry the earth filling than in the third type, but would be more expensive.

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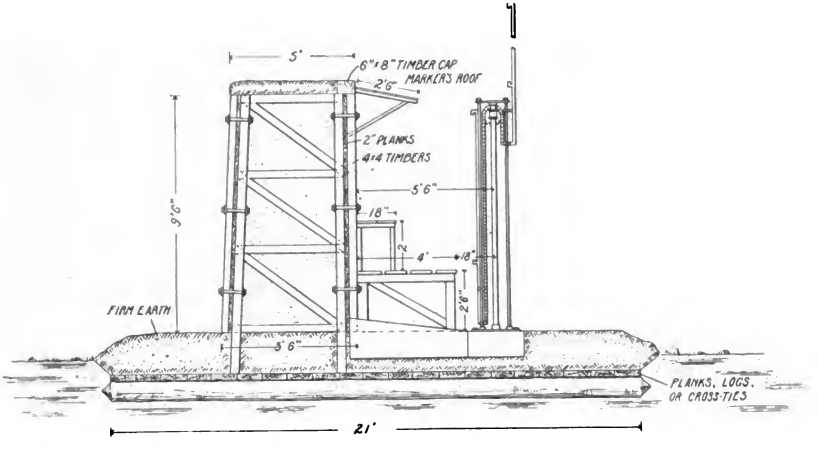

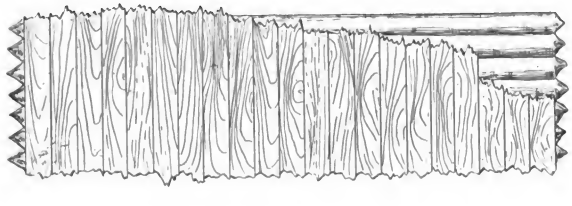

PLATE XII.

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122. These last two cribs, being intended for very marshy ground, do not have the weight capacity of the other types; it is therefore recommended that the embankment wall be of the double fence with fill type, this weighing less than any of the other embankments.

123. The construction of cribs as above is sometimes necessary, but it is not intended that a whole range be constructed in marshy ground. A range may be laid out on a piece of ground with splendid natural advantages with the exception that where the butts are planned to be erected, part of the ground is marshy. Constructing the butts on cribs to carry out the general plan is recommended in such an instance.

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CHAPTER IX.

Installation of Targets.

124. The method of installing the Government Sliding Target is described in The Firing Regulations for Small Arms 1904. Other wooden targets of the sliding pattern require special handling.

125. Metal Targets are installed without props. They depend for their support on a solid foundation.

126. This foundation is in the form of a target bed.

127. Plate XIII, detail 1 and 2 (page 66), shows the two forms of target bed recommended.

128. The better form is of cement. Into this can be sunk the stay bolts at intervals required for the type of target. This bed is described in chapter VIII. (See detail 1, plate XIII, page 66.)

129. The wooden bed, while not permanent, is of such form as to hold the metal target securely. It does not run the entire length of the pit as does the cement, but is usually about 8 feet long, being held with four anchors.

130. Railroad ties can be very well used for this form of target bed.

131. Cement beds for the Aiken or National Carrier have the stay bolts sunk into the cement while the same is being laid. In doing this, a template should be used, giving the exact position of the bolts.

132. It is essential that the target bed be absolutely level.

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133. The bed being laid, with the bolts in place, the target is then placed in position and the nuts on the stay bolts screwed tight.

134. Wooden beds are laid with anchors. These anchors consisting of iron plates with bolts passing through the center. These anchors should be put in holes dug for them, and earth well tamped to hold them in position.

135. The stay bolts should be put in holes bored through the wooden bed. These bolts being put in position before bed is laid.

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CHAPTER X.

Tunnels.

136. Tunnels are used to connect the different pits so that all pits are accessible at all times without cessation of fire. These tunnels run longitudinally. (See plate I, page 18.) The inside dimensions are, height 7 feet, width 4 feet at bottom, 3 feet at the top. Cement construction is the best, with an arched roof. (See plate XIII, detail 3, page 66.) Brick or masonry can be used, depending on local conditions. A wooden tunnel is shown in plate XIII, detail 4, page 66. This of course is not permanent, but in some sections of the country is recommended. The floor of these tunnels should be about 4 feet below the ground line, although it is sometimes necessary to put the tunnel entirely below the ground level.

137. The roof of the tunnel should be earth covered and sodded. This covering to be at least 18 inches thick.

138. On account of the length of the tunnels it is advisable to place ventilators in the roof at intervals of 50 feet. (See plate XIII, details 3 and 4, page 66.) These elbows are protected from rifle fire by small earth mounds. (See cut.)

139. The floor of the tunnel should have a 6 inch drain on one side, this drain having a normal flood slope to cess-pools constructed the same as recommended in the chapter on drainage. (See plate VI, page 42.)

140. The entrance to a tunnel at the firing point is

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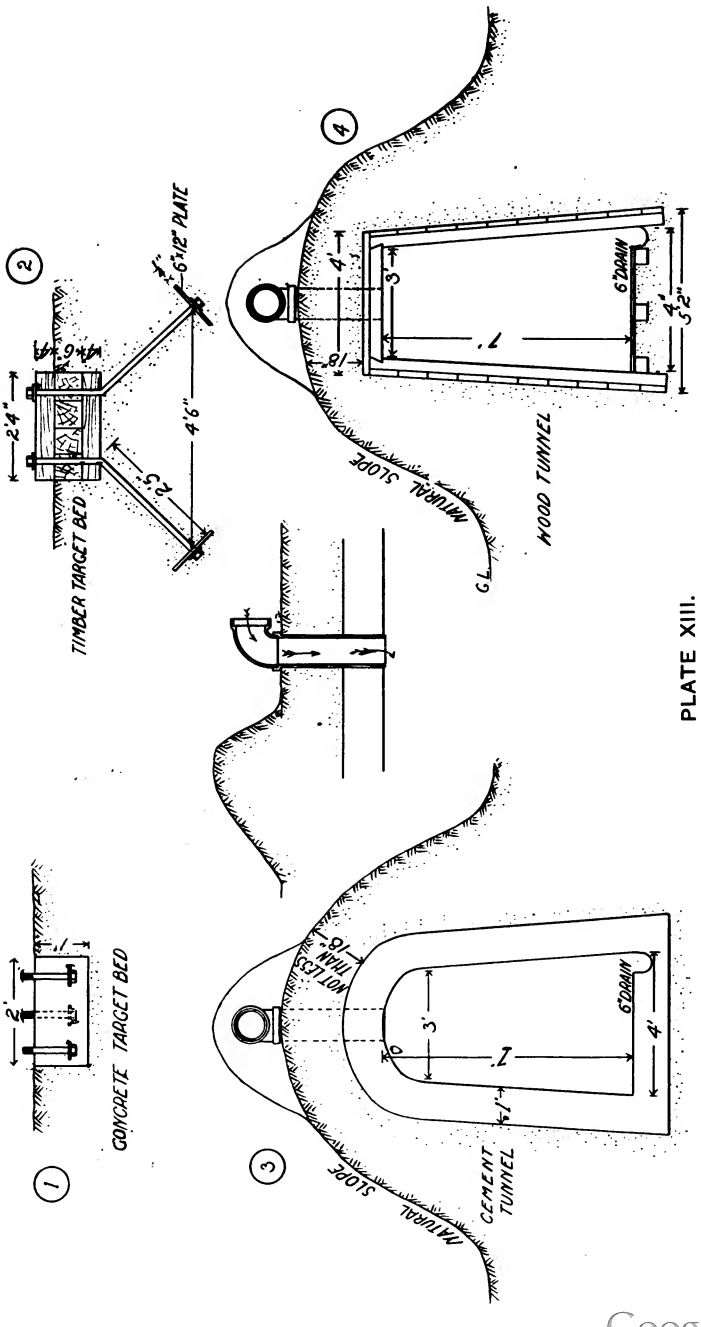

PLATE XIII.

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made with a few steps leading to a door in the tunnel. Another form is to enclose the entrance in a small wooden house.

141. The means of connection between tunnels and pits is shown in plates.

142. Tunnels should be lighted with electricity. A 16 candle power bulb every 50 feet will suffice.

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CHAPTER XI.

Backstops, Baffles and Screens.

143. Backstops are divided into two general classes, natural and artificial.

144. The natural backstop is one of the considerations in the selection of a range site. It may consist of a hill, river, lake, swamp, marsh or thick forest.

145. The artificial backstop is either a large embankment or fence.

146. Plate XIV (page 69) shows the form of artificial backstop recommended. It consists of an earth embankment about 30 feet high. This will catch the great bulk of the bullets. A double fence, similar to the one described in chapter VIII, paragraph 86 (see plate IX, No. 5), is built on top of this. This fence may be from 10 feet to 40 feet high. As the height increases it becomes necessary to brace or prop the fence.

147. The earth embankment should be sodded so as to help retain the earth with a slope of about 35 degrees from the perpendicular. The natural fall of earth (35 degrees from the horizontal) would be too apt to cause ricochets.

Baffles.

148. It sometimes becomes necessary to put baffle backstops on the slope of a hill used as a backstop, where the slope is gradual.

149. These can be made of sheet steel or wood. They should be placed perpendicular to the slope. They are

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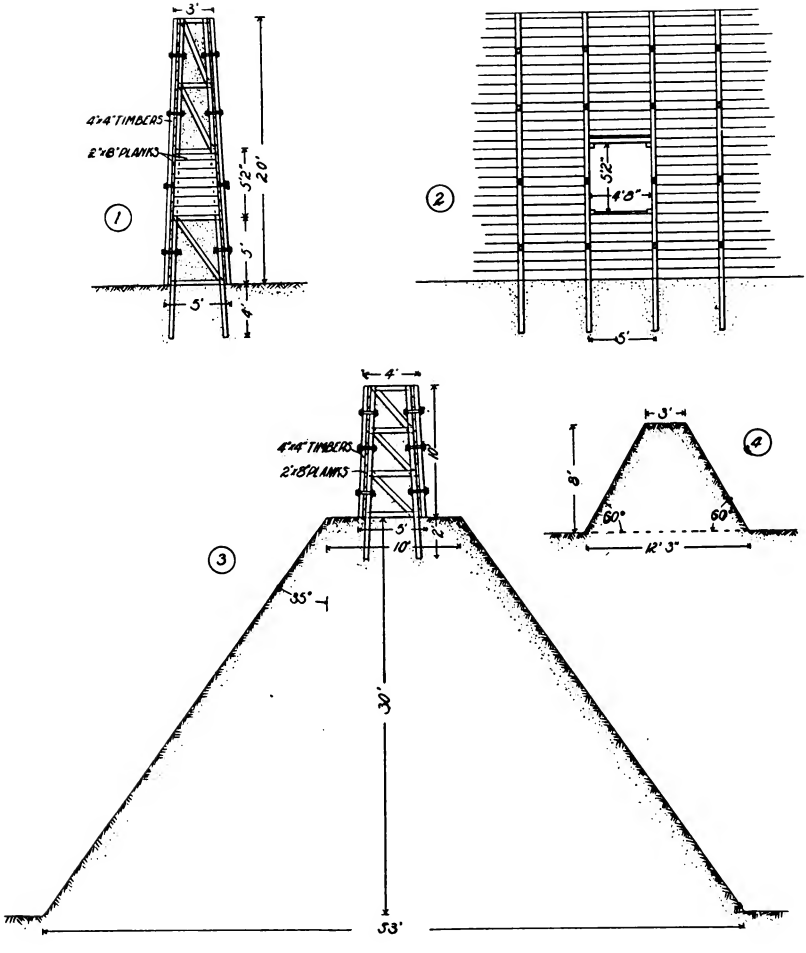

PLATE XIV.

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braced in this position. Baffles such as this will stop the flight of balls that ricochet from the side of a hill.

150. On certain ranges baffles are built with opening for the rifle fire to go through.

151. These baffles are built the same as the double fence described in chapter VIII, paragraph 86, except that openings are cut through the fences and these openings lined before the fill is put in.

152. The vertical size of these openings is determined by the trajectory of the ball at the range to be shot, and the ability to see the target. They should only be used as a last resort, because to be of use they must necessarily cut off from view a good deal of the range. In fact, they are only mentioned because they may have to be used where there is no alternative.

153. Screens, consisting of fences of the above type or steel, can sometimes be so placed on a range that they will protect dwellings or other buildings, the proximity of which might otherwise necessitate the abandonment of the range. They require no especial description, and their position, if necessary, is determined entirely by local conditions.

154. Ranges are sometimes established where a continuous butt is used and the firing-lines are permanently arranged in echelon. The firing-lines at the shorter distances can be protected from fire from the rear by establishing protective banks or screens in rear of these firing-lines. These banks or screens need no special description, as any one of the preceding forms can be used.

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CHAPTER XII.

Range Buildings.

155. The necessary buildings on a range are the office, the target building and store house, the magazine and the different target houses in each pit; also latrines.

156. The office can be of any type, where there are arrangements for keeping records, score cards and other statistical work on the range.

157. The target building and store house should be of sufficient size to store target frames for the range, score boards, flags and other accessories, with room for pasting on new targets. There should also be a general repair and storage shop, of the simplest construction. A good type is as follows: A plain barn structure one story high with or without loft, ordinary shingled roof. In this should be stored targets, target paper, pasters, extra marking disks, danger flags, black-boards, score-boards and all paraphernalia used by scorers and markers, including the danger flags and wind flags for the range. Telephones and, in fact, all supplies necessary for the proper operation of the range may be kept here.

158. A magazine of good solid construction should be located at a suitable place in rear of the firing-line with sufficient room for the proper storage of all necessary ammunition to be used during an entire season. This should be of brick or masonry, with a loose roof.

159. It is well to have a small wooden hut for the distribution of ammunition; this hut to be connected

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with the magazine proper by a small wooden passage-way which need not be over ten feet long. This arrangement makes it unnecessary for the men to whom ammunition is being issued being in the magazine.

160. In each butt there should be a target shed or house immediately in rear. These sheds should be so distributed that the markers will not have to carry targets too great a distance. The size of these sheds to be determined by the number of targets to be stored. The roof of these houses to be below the top line of the embankment. In these houses there should be room for marking disk, danger flags, telephone, and other accessories used at the targets.

161. On ranges where large meetings are held, it is a good idea to have small portable offices, about the size of sentry boxes. These offices to be placed in the rear of firing points any distance from the main office for the sale of re-entry match tickets.

162. Club houses are not included in the list of range buildings, as they are not indispensable.

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CHAPTER XIII.

Flags, Observation Equipment and Accessories.

163. There are two kinds of flags used on rifle ranges: wind flags and danger flags.

164. The wind flags are made of different sizes, but the larger they are the better. A pennant 6 feet on the hoist and from 25 to 30 feet on the fly seems to give the greatest satisfaction. The point of a pennant will show light winds, and the size of the flag will give a better unit on which to base the force of the wind.

165. In the model rifle range (see frontispiece and chapter II, plate I, page 18-a) wind flags have been placed at every hundred yards at the dividing-line between the different sections of the range. This is a good rule to follow and will insure the range being properly flagged. One great trouble with numbers of fine ranges is that there are not sufficient wind flags to give all men an equal chance of judging the wind. Of course, in the interest of economy it may be necessary to cut down this number slightly. In this case they might be placed at every 200 yards instead of every hundred, but we do not recommend that the flags be placed on lines of fire too widely separated. It is not well to have the flags separated by more than 300 feet.

166. In case the range is located in a section of country where there are peculiar currents coming from different directions, it may be well to place flags some

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distance from the range so as to give men an opportunity of catching a change of wind before it strikes the range proper. Some ranges are not flagged with any attempt at regularity, but have flags placed where it is thought they will do the most good. This in order to save expense. This is not a wise plan to follow, but where only a few flags are to be used, they should be placed where there are eddies or currents or peculiar conditions of wind. The general rule in this case to follow is to put a flag wherever there is a gully or depression and on high ground. It is advisable to place flags along a river bank, in case this is near the range, to show whatever wind effects may come from that direction. Sometimes, due to peculiar topography of the ground, currents running in different directions will join and cause rather unusual effects. At the junction point of these currents it is well to place a flag, as otherwise it would be almost impossible to tell what is happening at that point.

167. On a well-flagged range such as recommended, it is advisable instead of having these flags of all one color to have them of combined colors. Plate XV shows the different patterns that can be used for this purpose. These combinations can run down each line dividing the sections, using two colors for each of these lines.

168. In placing the flags on the poles it is well to place the same flag to the same pole at all times, so that men using that range get familiar with the different flags and refer to them, especially in the matter of coaching, by their color and pattern; thus, if a coach wishes to call the attention of a certain flag to the man shoot-

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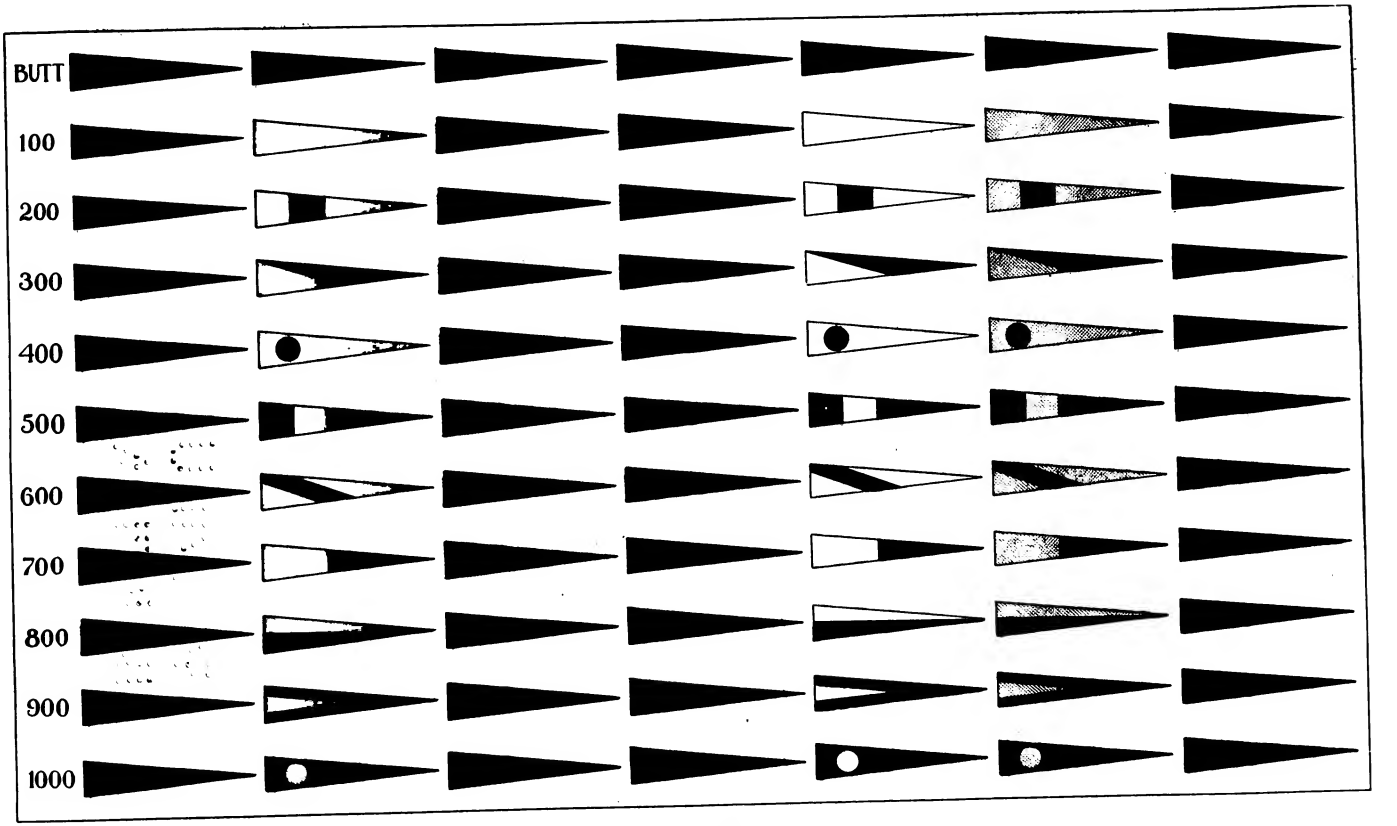

PLATE XV.

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ing, asking him to watch that flag to get his wind corrections from and no other, he can readily do so by saying flag of such and such colors of a certain pattern.

169. The poles for these flags should be 46 feet in length, 40 feet of this to be above the ground and 6 feet to be sunk in the ground. These poles can be made of pine, hemlock, or spruce, and are 10 inches in diameter at the base and 5 inches at the top. It is well to have these flag poles on all ranges so placed that they will not be hit by bullets in describing the curve against the wind caused by making allowance for the wind. On the model range, 30 feet on either side of the flag pole has been allowed for the flight of the bullet. This not only to protect the pole but also to prevent the flag when flying interfering with the bullet in its flight.

170. Danger flags are small red flags 24 inches wide, 36 inches fly, which are used both in the pit and at the firing-line. When these flags are elevated it means that firing is to be discontinued on that target whether the flag is shown at the target or at the firing point. There are some instances where it may be necessary to shoot across a road or where a road crosses in rear of the pits or at some point where there might be danger of an accidental shot falling. Of course, a condition such as this should be avoided if possible. In this case, it is well to have a pole placed at whatever point people are apt to come from with a red flag hoisted on this pole during fire, as a warning to people that firing is going on at the range. It is advisable also to have a sign posted at this pole stating that when the flag is flying that road should not be used. This can only be done in

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the case of private roads. Danger flags for this purpose should be rectangular in shape, about 12 feet fly and 6 feet hoist. There are other danger flags sometimes called signal flags which are used especially in the case of ranges located so that the bullets are falling where vessels or vehicles may be passing. These flags are so placed that they can be seen clearly from all parts of the range. The instant any object is sighted coming within the fire zone the flag is hoisted as a signal to those on the range to cease firing. These flags should be red and of sufficient size to be easily seen and attract attention.

171. Wind clocks are nothing more than improved weather vanes, the vane in this case being fastened to the shaft. The lower end of this shaft terminates in a bevel gearing, the actuated gear working on a hand on a clock dial. This dial reads so that a wind blowing down the range from the rear will indicate 6 o'clock. (See plate XVII, No. 1, page 83.)

172. (a) Anemometers, while not necessary, are now being provided on all well equipped ranges. They are of considerable help to riflemen in determining the velocity of the wind.

(b) Most of these are the recording type or require computing, although some are direct reading. A direct reading anemometer, for use in combination with a vane, has been designed by Dr. W. G. Hudson (see plate XVI). The anemometer-vane is substituted for the usual vane of a wind clock, and is connected with the clock by bevel gearing in the regular way, so that the clock continues to show the direction of the wind, while the attachment shows its force.

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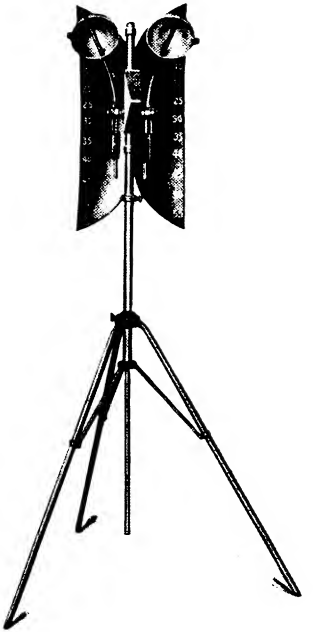

PLATE XVI.

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(c) The following is a description:

(d) The principal parts of the anemometer are a scale and balance cups.

(e) The scale is on the blades of the wind vane. This wind vane is so shaped that the tails broaden out, terminating in arcs of circles whose common center is the axis of the balance cups.

(f) The tails of this vane are made of two plates fastened together to form a knife blade edge at the shaft, and flaring apart horizontally toward the broad ends.

(g) Each of the sides of this vane is so shaped as to present a concave surface to the wind. These concave surfaces flare out, their extreme ends terminating in the arcs above mentioned give surface on which the scale of miles per hour is placed. This enables the scale to be read with the knife edge or arrow end of the vane toward the individual.

(h) The convex or rear surfaces of the two sides of the vane also have the scale of miles per hour on them. These can be read with the arrow end away from the individual. It is of course no trouble to read from the side.

(i) The velocity of wind in miles per hour is determined by the effect of the wind on two aluminum cups, so balanced that it requires a wind of a certain velocity to move them a given distance. This movement is shown by pointers connected with the shaft carrying the cup-arms, said pointers playing over the scales painted on the vane. These fingers with no wind blowing point to the figures 0 at the top of arc ends of the vane. As the cups are forced back by the pressure of the

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wind, the fingers are depressed, following the curves of the arcs at the ends of the vane. The scale reads in units of 5 miles, but velocities between these readings can be easily determined with the eye, or can be added to the scale. The ends of the fingers curve around the ends of the vane, so that a reading can be gotten with the vane pointing in any direction. As there are two cups fastened to the same axle and two fingers moving as one, one finger on each side of the vane, no difficulty is experienced in getting the velocity of the wind instantly.

(j) This vane of course also shows the direction of the wind by the reading on the clock dial.

Semi-Automatic Danger Signal.

(See plate XVII, No. 2, page 83.)

173. (a) A description of an automatic danger signal follows:

(b) It consists of a square of red of size that will obscure the bull's-eye. This square is fastened diagonally to a counterbalanced arm, the length of the arm from the axle to the center of the square to be of such length that the square when in a vertical position will obscure the bull's-eye. When this arm is pulled to a horizontal position the counterbalanced end engages a trigger which holds it in this position. When the arm is horizontal the danger signal cannot be seen from the front.

(c) To use the signal, it is merely necessary to pull the handle of the trigger and the danger signal is displayed. Before firing is resumed, the danger signal must be returned to its position of rest.

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Telephones.

174. No range can be satisfactorily run without a complete telephone system. It is advisable to have, if possible, one telephone to every four targets. The least that will give satisfaction is one telephone to every ten targets.

175. These telephones should be as compact as possible. Those in the pits need not necessarily be portable, as they can be mounted in boxes on the embankment wall.

176. On ranges with continuous firing-line, butts in echelon, the telephones at the firing-line can be of the same type as the pit telephones. They can be in boxes, mounted on heavy posts sunk in the ground. On ranges of other types where it is necessary to use portable telephones, the above will not be of much use.

177. In these cases, the field telephones used by the U. S. Signal Corps are recommended. They are strongly built and will stand much rough usage. No stand is needed with them. A light, strong easel or tripod should be provided, and the telephone used with this.

178. Instead of these, a pointed staff on the order of a Jacob's staff, with a small platform on the top can be used.

179. Connecting plugs can be sunk in the ground in an iron box, the telephone carried on the tripod or easel to its position at the firing-line where it can be set up and connections made. At Bisley, England, they have a small wooden platform with a long rod underneath it fitting into an iron pipe. This rod has a spring

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catch near its bottom which when the rod is pulled out a certain height springs out and prevents the rod receding into the pipe. The small field telephone is placed on the wooden platform held by a couple of hooks, and the connections made with plugs in the ground. On disconnecting the telephone, it is merely necessary to press the spring catch with the toe and press down the iron rod until the platform rests in its box in the ground. The lid of the box is then closed and locked.

180. The telephone wires should be sunk in a trench in the ground. They are run through the conduit, provided in the embankment wall. (See plate I, and par. 18, page 22.) Lead covered cable should be used for all this wiring.

181. The Signal Corps outlet box, if used at the firing points, should be as close to the ground as possible.

182. An excellent system which had its origin in Switzerland is to have an electric bell or buzzer at each target and a push button at each firing point in direct connection with the bell. These push buttons are either fastened on the stakes at the firing points or have connecting plugs on these stakes, in which case the scorer carries a pear-shaped push button connected with a short piece of wire. Whenever a shot is fired the scorer at that firing point promptly presses the button. This draws the attention of the marker to the fact that a shot has been fired on that target, when the marker can pull the target and examine. This relieves the strain on the marker of watching a target in the air and means better service with less fatigue, besides avoiding delays that will occur when shots do not hit the target.

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Accessories.

183. Under the head of accessories are black-boards, score-boards, marking-disks, chalk, telescopes, field-glasses, pencils, score cards, spotters and stakes.

184. The black-boards should be boards 23 inches by 48 inches mounted on a simple easel. Plate XVII, No. 1, page 83 shows usual style used at most of the ranges. This board is ruled off in white paint for the proper scoring of two sighting shots and ten record shots with total for six men. There is a small ledge underneath for chalk. On one side of this easel is screwed a telescope holder or clip which is used by the scorer to hold the telescope pointed at the target.

185. The score-board should be a small lap board of the ordinary clip pattern. These can be readily made of ¾-inch pine or white wood 12 inches by 18 inches with common office clips mounted near the top under which to hold score cards. It is a good idea to have a ledge at the bottom of this board which will prevent pencils rolling from the board.

186. Marking-disks should be of three sizes: 10 inches in diameter for short range, 20 inches for mid range, 30 inches for long range. These should preferably be made of sheet iron mounted on the ends of poles 10 feet long and from 1½ inch to 2 inches square. Poles can be made of spruce or hemlock. Where the single target system of marking is used, which is preferable for long range work, these disks, instead of being of metal, should be wood, square in shape, and painted to represent the marking-disks.

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187. Scorers should be supplied with a good grade of white chalk.

188. The telescope to be used by the scorers can be of a cheap pattern with an object glass from an inch to an inch and a quarter or an inch and a half, of about 15 to 20 power. These are preferable to any field-glass, as they can be mounted in the telescope clip on the blackboard and always directed at the target. These telescopes can be procured at a price of from $5.00 up to about $10.00.

189. When field-glasses are to be used an ordinary 4 to 5 power field-glass would serve the purpose, costing from $5.00 to $10.00. These, however, are not in any way as good as the telescope.

190. All scorers should use indelible pencils in scoring.

191. Score cards should be of such a nature that there will be a main part and a stub. It is well to have these of the same size, separated by the ordinary card perforation. The cards should be of different colors for the different ranges. Where it is a team match a card of sufficient size to take the scores of all competitors on the team should be provided, depending of course on the number of men on each team.

192. Stakes for the different firing points should be made of 4 inch by 4 inch joists in lengths of 2½ feet, pointed at one end. These stakes are driven into the ground so that 18 inches will project above the ground. They are painted white for short or mid range with black numbers. Black for long range with white numbers. Red for skirmish with black numbers.

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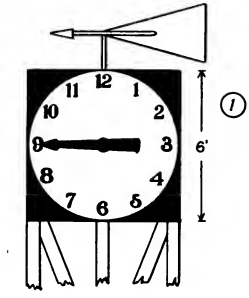

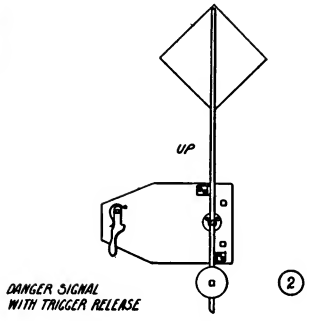

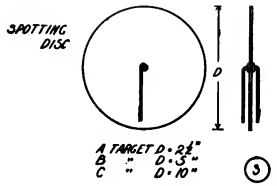

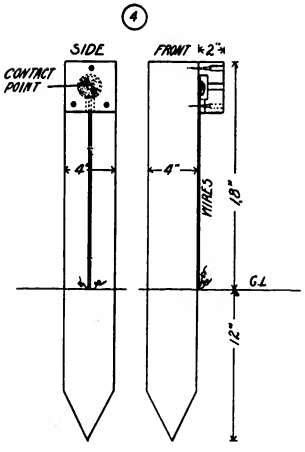

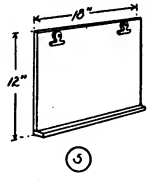

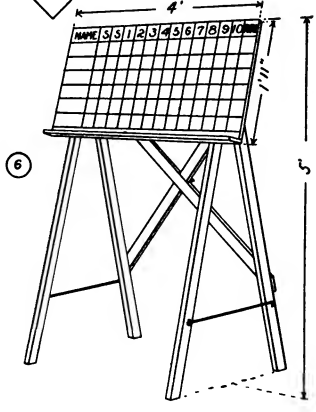

PLATE XVII.

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193. When electric push buttons are used on the stakes they are either mounted on one side near the top or located near the ground to be worked by the foot, the principal thing being to protect the contact point from rain. Plate XVII, detail 4, shows a simple arrangement of a contact point. An empty cartridge shell is inserted in the hole in this block which is used to make the electric connection. When it is desired to have the push button worked by the foot, a block similar to this can be mounted near the bottom of the stake, having another block placed immediately above it. From this block a small strip 6 inches long, 1 inch thick and 2 inches wide can be suspended by a hinge with its lower end immediately over the hole in the lower block. When an empty cartridge shell is inserted in this hole and the strip allowed to fall over it, a pressure of the foot of the scorer against this hinged strip will cause the contact to be made, thus doing away with the necessity of the scorer bending over.

194. The covering block is made of wood 4 inches by 4 inches by 2 inches. This has a hole $\frac{1}{2}$ inch diameter through its center. The rear of this block is cut out to allow room for the contact point. A channel is cut in rear of this block from this recess downward, with room for the wire and also allowing whatever water might accumulate in the recess, to run off. This block is held to the stake by the 2 inch screws counter-sunk.

195. The contact point in the above-mentioned block consists of the base of an ordinary push button, preferably made of porcelain. This is mounted on the stake in such manner that the covering block will have the

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hole immediately over the contact point of the push button.

196. On the Camp Perry range, Ohio, a system is used in which the connection plug is placed in a pipe coming up from the ground, the hole of this pipe being bent over so that the connection plug faces the ground. The scorer carries a pear-shaped push button with a length of wire and a connection plug which fits into the socket of the bent pipe. This is a very complete form for controlling the buzzer, but has the disadvantage of requiring the scorers to carry these push buttons with them.

197. Spotters are made of circular pieces of pasteboard 2½ inches in diameter for short range, 5 inches in diameter for mid range and 10 inches in diameter for long range. These are white on one side and black on the other. A piece of wire is run through the center bent into the form of a hook. (See plate XVII, No. 3.) These spotting disks are used to indicate the exact position of a shot. The disk is hung in the shot hole. The black side out if the shot is in the white portion of the target. The white side out if the shot is in the bull's-eye.

198. It is well to have a few black disks with wooden plugs instead of the wire. These to be used to spot shots through the wooden frames.

199. Some ranges use red or green disks for spotting shots. But they require a telescope or field-glass in order to see them.

200. Pasters are small square or circular pieces of paper gummed on one side and pasted over the shot holes. They are made in black and white. A better

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way is to use a thin shellac and pasters without gum. The target is touched with shellac over the shot hole, the paster put on, and then gone over with shellac. This way has the advantage of not washing off readily in a rain storm.

201. Some sort of seat should be provided for scorers. This may consist of the ordinary camp stool or a chair with desk in front. This latter being easily made of the wood from ammunition boxes. The method of construction can be readily seen in plate XVIII, page 87.

Number Boards.

202. The numbering of the targets can be done in three ways. By placing the numbers in front, on a fence in rear or to one side or the other of the targets. In the different styles of ranges recommended it is advisable to have the number boards on the slope of the butt in front of the target itself. There are some ranges where these numbers are cast iron. This is not recommended, as it is too expensive, the numbers are too unwieldly to be shifted and then there is always the danger from ricochets. The boards should be constructed of planking about 6 to 8 feet square with the numbers painted on them in white on a dark green background. These number boards can be nailed to stakes driven in the ground and are entirely satisfactory and easily repaired.

203. Of course, where an artificial embankment has been built in rear of the targets numbers can be placed on the fence immediately in rear and above the targets. These, however, can only be placed in such position when the target is in front of this butt. On the skir-

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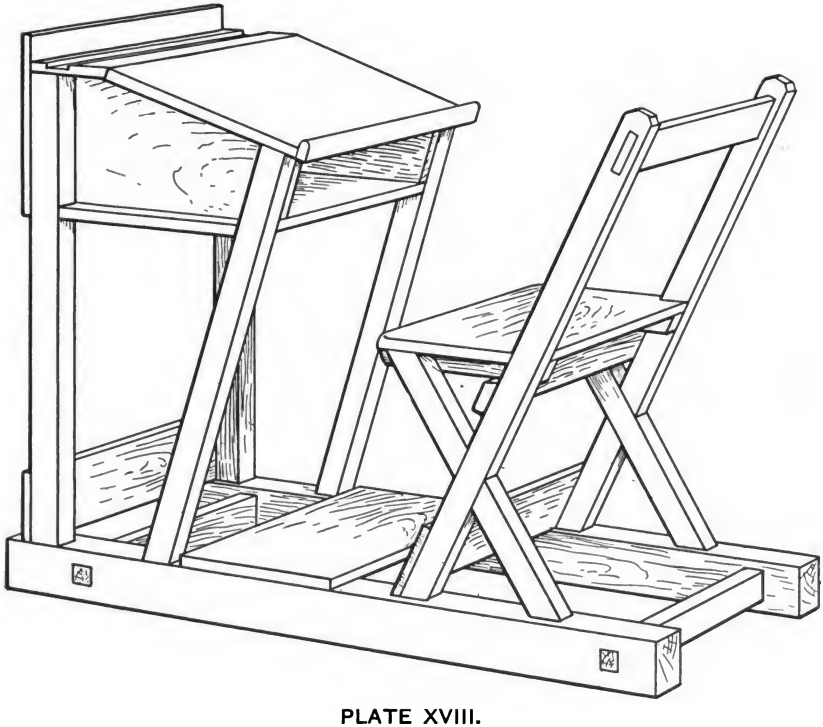

PLATE XVIII.

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mish field, owing to the double use to which the embankment is put, the numbers should be placed in a slightly different manner. In this case, it is well to have them a sufficient distance in front of the targets so that they will not interfere with ricochets that may strike the ricochet bank used in skirmishing. In the range recommended this would put them at least thirty feet in front of the target itself.

204. A good type for these number boards is to construct them 4 feet by 4 feet, pinning them at their lower edges by the stakes driven in the ground so that the boards can be raised into position and dropped out of sight. When the range is being used for slow fire, it is merely necessary to stand these boards up with a scantling hinged to the back, the same as an easel, and when the range is to be used for skirmishing drop these planks in rear, allowing the number board to fall flat on the ground out of sight, and the danger of interfering with ricochet shots.

205.* The skirmish groups require number boards immediately in rear or a little to one side or the other of the group itself. These number boards can be made 4 feet by 4 feet, nailed to a single upright beam. This beam need not be over 2″ x 4″. It can be held in position by allowing the end of the beam to pass through a bent strip of iron into a socket immediately in rear of the embankment wall of the 600 yard butt. It is advisable to place this a little to one side of the group so as to prevent it being shot to pieces by shots going through the figures.

* See paragraph 7, page 15, and paragraph 19, page 23.

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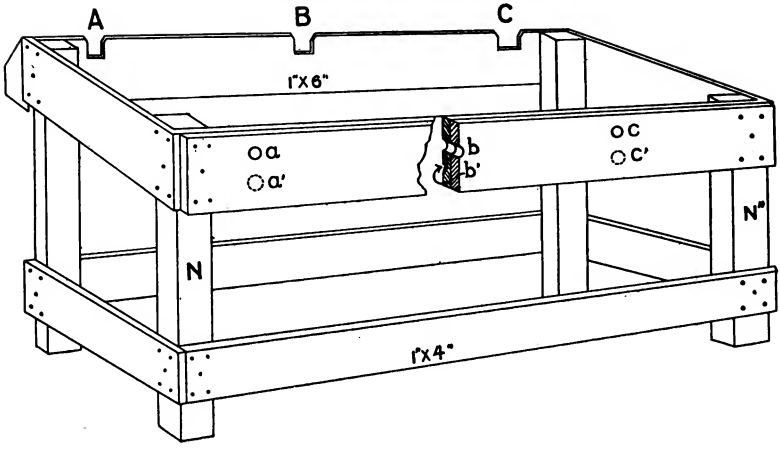

LENGTH OF M AND M' = ABOUT 36"
" " N " N' = " 30"
DISTANCE FROM A TO B' ABOUT 24"

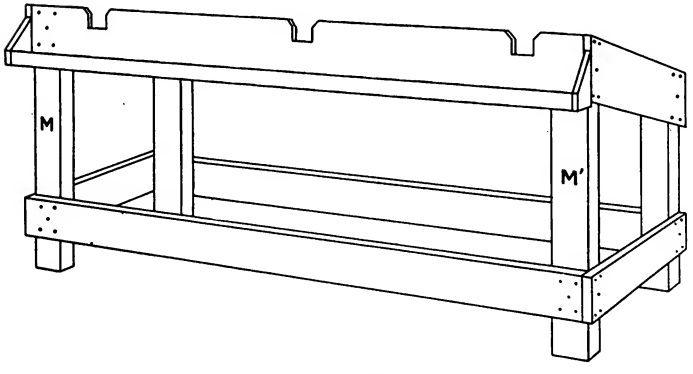

PLATE XIX.

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206. If the skirmish figures are mounted on the *B* target, the numbers for the regular targets will be sufficient.

207. A rather convenient adjunct to a properly equipped range is a rifle cleaning rack. While this cannot be considered as essential to the proper running of the range, it has one advantage; that is, by having these racks on the range ground at convenient places it will tend to confine the cleaning of arms to these spots, thus preventing a great deal of unnecessary scattering of debris. The following description of plate XIX will suffice for all practical purposes:

The rifle rests in *Aa, Bb,* or *Aa', Bb',* etc., the muzzle being inserted in hole *a,* or hole *a',* etc. Holes *a, b,* etc., are drilled through holes *a', b',* etc., are drilled half-way through as illustrated. The square cuts *A, B,* etc., are of sufficient width to receive snugly small of gun stock. Distance *A* to *a* is such that trigger guard will bear snugly against inside face of *A*. Front legs (*M* and *M'*) are of such length as to facilitate cleaning the rifle when in the rack. Rear legs (*N* and *N'*) are slightly shorter than (*M* and *M'*) giving rifle a slope. Distance from *A* to *B; B* to *C,* etc., is such as to facilitate cleaning, number of spaces *A, B, C,* etc., depends on circumstances. If for use in squad rooms, two or three spaces will suffice, and the rack should be neatly constructed. For outdoor or range use the number of spaces *A, B,* etc., would be greater, and the rack may be made of rough material. This sketch is designed to illustrate the mode of construction, hence may be modified. This type is used by the U. S. Marine Corps.

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CHAPTER XIV.

Water Supply and Sanitation.

208. An absolutely essential feature to the proper equipment and conduct of any range comprises the water supply, in conjunction with the sanitation of a range. The health of both employees and participants in attendance at the range should be zealously guarded, and to that end economy in construction should not be the prime consideration. Potable water should be supplied through a series of outlets or faucets, conveniently distributed, not forgetting the markers in the pits, and sinks or latrines should be provided, not only adjacent the firing-lines, but also at such point or points midway down the range, or at least adjacent the thousand yard range, that the markers and employees should have access to same with the least loss of time, and without danger to themselves during firing. Incidental to the water supply should be provision for fire service, but the important desideratum is absolute certainty, affirmed by proper analysis and examination, of the pureness of the drinking water.

209. The water supply may be piped to the range from some pump pressure system or may be local, from elevated tanks supplied by artesian wells or other source on the ground. The fire protection may be afforded by service from the foregoing, or even by buckets properly stationed; not forgetting provision for hand-grenades or other emergency protective means especially about the range buildings and magazine.

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CHAPTER XV.

Single Target System.

210. The single target system is recommended for use in all long range competitions whether team or individual. The method of using this is to balance one target with a weight of the same amount as the target on the other carrier, so that the target frame will run smoothly. The wooden marking-disks are stood up in sockets on one side of the target, the 5 and 4 on either side of one disk, the 3 and 2 on either side of the other. The red flag is used to signal a miss.

211. The poles of these disks should be mounted far enough apart so that either disk can be turned with the frame surface toward the firing-line and not interfere with the other disks. This will place them about 15 inches apart. The top socket should be notched to receive the disks to prevent their turning.

212. The method of using this target is, that when the shot is fired and the target hit, the target is pulled and the value of the shot indicated by taking one of the disks of the relative value, raising it so as to clear the notch, turning it with the proper side toward the firing-line, and letting it rest in the notch parallel to the firing-line. This will hold it in this position. The target then has a spotting disk placed in the shot hole, the old hole is pasted, and the target run back into position, the marking-disk then being raised from its notch and placed back into its original position.

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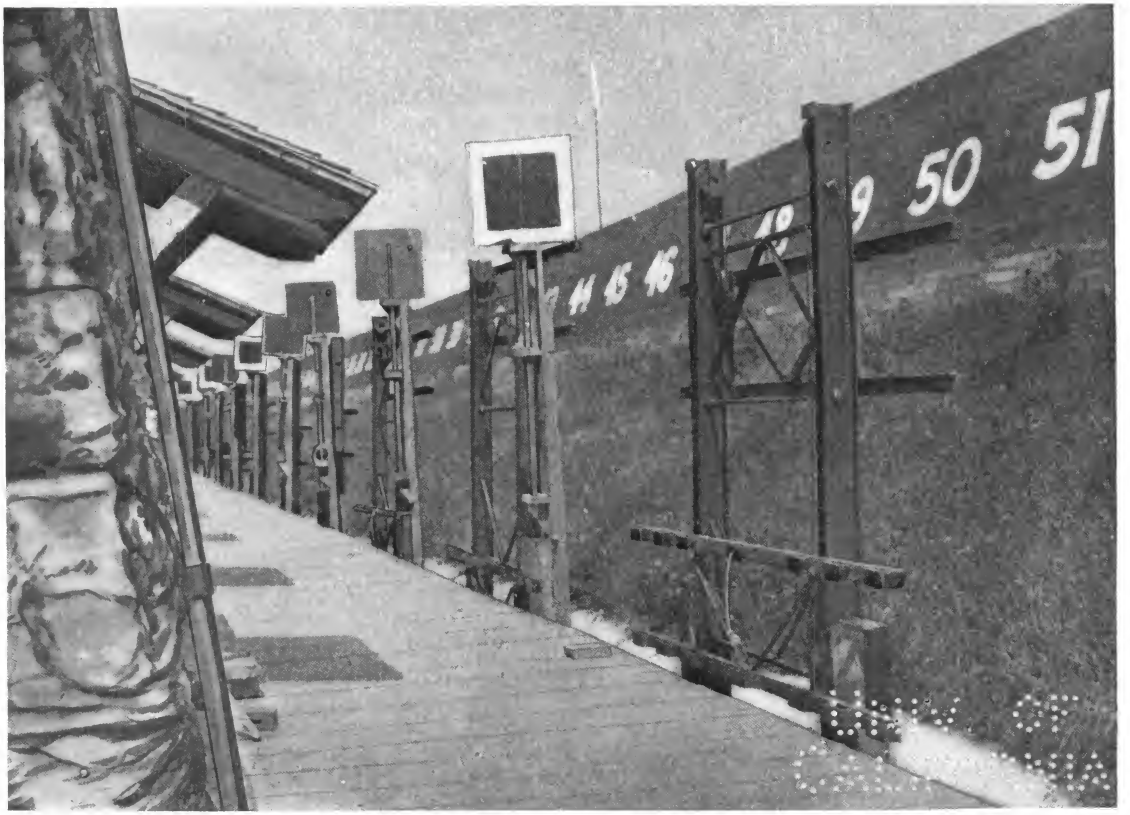

PLATE XX.

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213. The advantage of this system is that at long range it gives a man the position of his shot without waiting for the other man to fire, giving him sufficient time to make his calculations before making his next shot. At the same time, in case the other man should miss, it does not in any way affect the man who has hit the target.

214. Plate XVIII shows the marking-disk used at the Rockliffe Range, Ottawa, Ont. It seems that these would be better placed on the embankment wall, as then there would be less danger of markers being hit, where one man would spend his time working these disks, as in our big competitions.

215. (a) A marking signal has recently been designed by Capt. K. K. V. Casey, for use with the single target system. This device has the advantages of increasing the speed of marking, avoiding delays due to inaccurate marking, to the target not being returned to its proper position, and other trifling delays, such as caused by the wind blowing disks around, etc. It consists of a light frame of tubing with four counterbalanced semaphores for signals. It is placed on the tread adjacent and normal to the plane of the target and at its left side. (See plate XXI, page 94.) (See also plate XXII, page 95.)

(b) The method of using this marking signal is, that as soon as the target is hit and sashed, the proper signal is pulled into position by the marker, in which position it remains, being held by a trigger. The signal will remain in this position until the target is returned to its proper position. When the marker returns the target,

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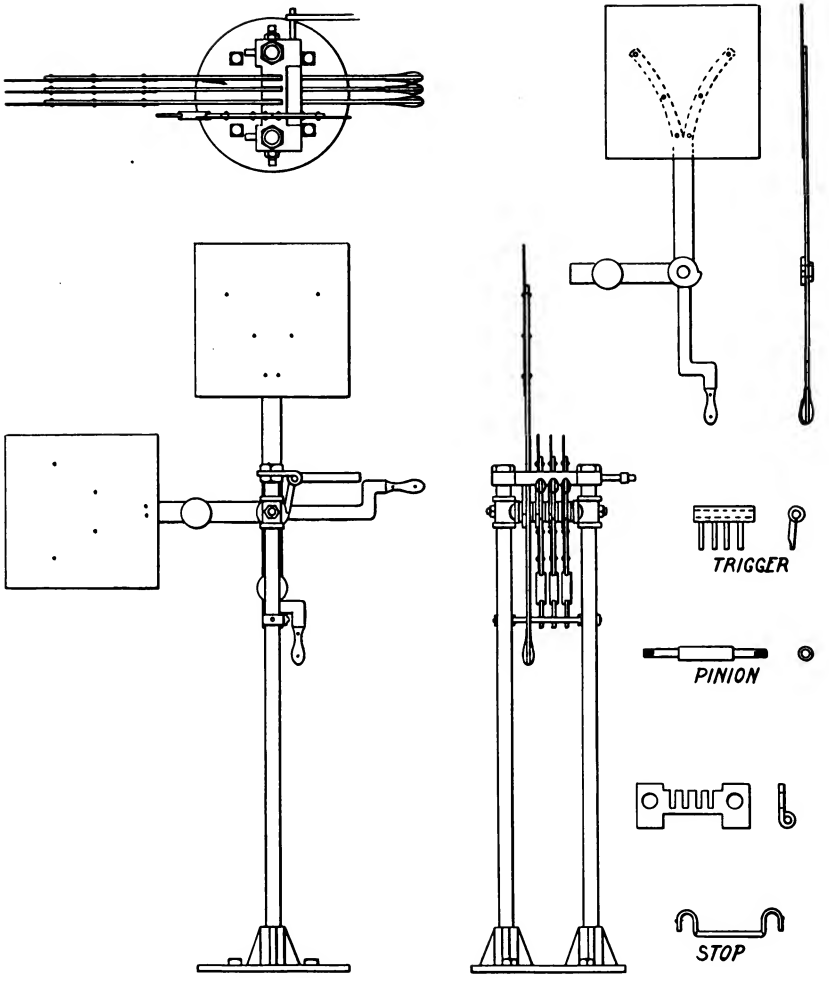

PLATE XXI.

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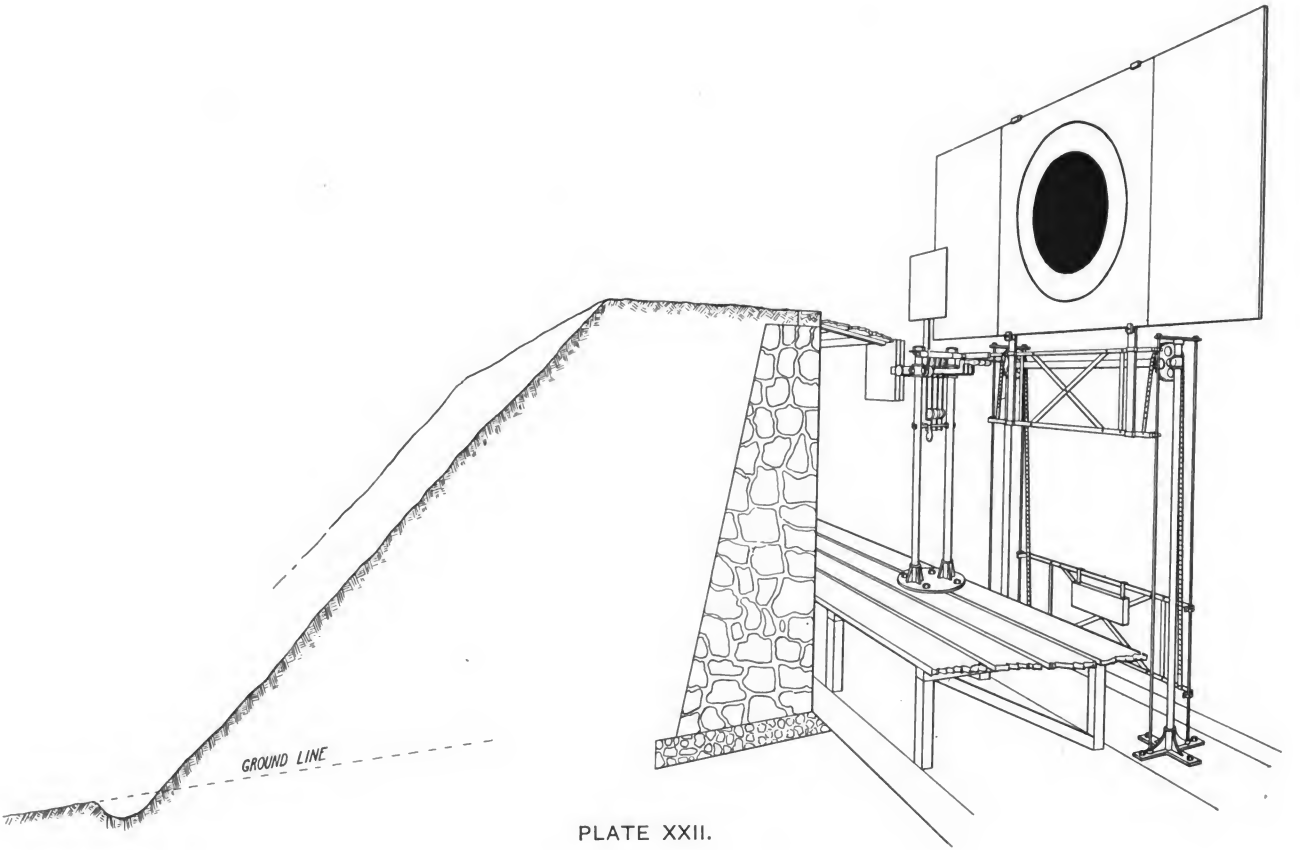

PLATE XXII.

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the striker on one end of the target carrier engages the trigger, loosening the sear from the tumbler, allowing the signal to fall to its position of rest. If the target is not returned to it proper position, the trigger is not engaged and the signal will not fall, thus indicating to those at the firing point that the target is not at its full height.

(c) The signal is not affected by the wind, and there is no possibility of a man allowing a signal to remain in position after he has returned the target to its proper place.

It is believed by using a device of this sort that it will do away with most of the delays now occurring in big matches.

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CHAPTER XVI.

Small Ranges.

216. The construction of a range suitable for the use of a single company or rifle club requires close attention to the details of the construction in order to avoid unnecessary expense on account of the small amount of material and the small amount of each kind of work required in this sort of range.

217. It is very seldom necessary to build a range of this type with more than four targets. The best plan follows: The range to be of the continuous firing-line, butt in echelon, type, consisting of four targets in two pits, the target frames being capable of taking the *A*, *B* or *C* target. Each pit would be 48 feet long allowing two targets with 24 feet between centers of targets, thus giving 6 feet protection beyond the ends of *C* targets. The range should be established with a line for flags going down in the center, the pit on the left being placed with its extreme right end a distance not less than 24 feet from this center line of flags so that the end target would be at least 30 feet from this line. The pit on the right to be established with its extreme left end not less than 24 feet from this line of flags. This gives practically two ranges. One of these pits should be 1000 yards from a common firing-line, the other to be 800 yards. This will place the two pits 200 yards apart in the direction of fire.

218. With a range of this type it is recommended that

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on the left-hand section be established the skirmish range. Firing points should also be established on the left-hand side for 200, 300, 500, 600, 800, 900 and 1000 yards slow fire. The right-hand side should have firing-lines established for 200, 300, 500, 600 and 800 yards and 350 and 400 yards skirmish fire. On account of the distance separating the right-hand and left-hand ranges, it would be possible on a range of this type to use the 200 yard range on the right-hand side while the 500 or 600 yard range on the left-hand side was being used. It would be also possible to use the 600 yard range on the right-hand side while 800 yards was being used on the left or even the 600 yards. The 500 yard range could be used on the right-hand side with the 600 yard range on the left. The 600 yard or 800 yard range could be used on the right-hand side with 800 or 1000 yards on the left. While shooting at 600, 800 or 1000 yards on the left, it would be possible to skirmish on the right-hand side. A range of this type is shown in plate XXIII, page 99. This would be the ideal company range where the ground would be such as to call for this type.

219. It might be, however, that only one target on either side of the center line of flags could be established. It is also possible that the line of fire on the left-hand side of the range would be toward some other point of the compass than the one on the right. This type of range should be such that the lines of fire diverge; in no case should they cross. Any number of departures from the given type are possible (in the general chapter on range construction the different types are thoroughly

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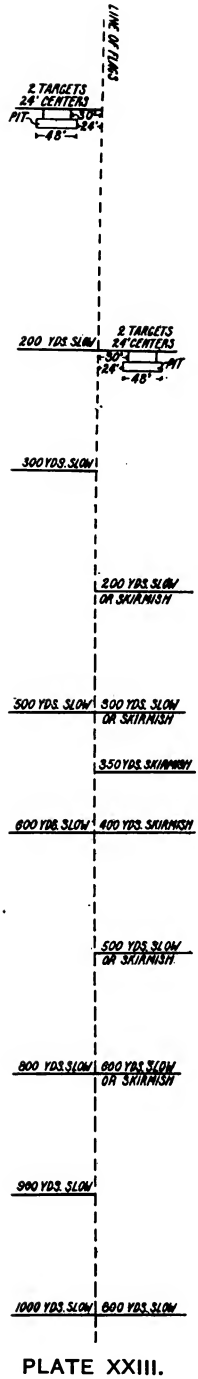

PLATE XXIII.

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covered). Any combination is possible, depending entirely on the topography of the ground.

220. It is not advisable to establish more than two butts, unless expense is no object or on account of the nature of the ground it is impossible to place the firing points as suggested. This is all a matter to be settled by local conditions. Of course, if expense does not have to be considered, even with the ground as mentioned in ideal conditions, a range of greater flexibility can be built by the establishment of more butts, thus doing away with the necessity of having more than one firing-line. But a firing-line in a majority of cases can be built at a much smaller cost than it would be required for another butt. It is impossible to state off-hand what the expense per running foot of any of the different types of butts recommended would be, as this all depends on local conditions, but there is no doubt that on the average the butt built with two fences and earth-filled would be the cheapest.

221. In the matter of drainage, a small butt only holding two targets can be very easily drained, as it requires in the case of a sunken pit a very small cesspool and in the case of a surface pit merely a small channel to carry off the water. The poles in the line of flags established down the center of the range can be used to carry telephone wire. On a small range of this sort a buzzer system is not necessary, but a telephone is of material advantage. It is only natural on small ranges that men in the pits are very much interested in what is going on at the firing-line, and means of communication between the firing point and pit are very

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essential; also the fact that on most company ranges the men firing take their turn marking, it is rather necessary that they should be kept posted in order not to get them into surly moods. The small company range is where most of the developing of rifle shots takes place, as on it more attention can be paid to the individual firing of the different men.

222. In the construction of a range of this type no attempt should be made to build one that can be used at any time for a large match. The range is meant only for the use of the local company and should be considered by them as their range. Of course, matches for the men of the company can be very easily held on this range, but nothing larger than this should be attempted.

223. It is not advisable to make any special provision for water supply or sanitary arrangements. The range being a small one, there is no danger of congestion, and expense of this sort is mere extravagance. If there is means of getting water from local water supply without great expense, it can be done, but no long pipings should be attempted.

224 (a) There should be two buildings provided on this range, both of which should be so constructed as to resist the attack of hordes of small boys that usually infest rifle ranges. In no case should there be more than one window in either of these buildings, as they are merely store houses. These windows should be bolted on the outside in such manner that the bolt can be locked from the inside only. The doors should be strong, with cylinder locks. In no case should padlocks be used, where there is a hasp and staple, as these are too easily removed with screw-drivers.

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(b) One of these buildings should be placed near the butt, preferably at the one nearer the firing-line, and should be used to store targets, marking-disks and staves, and other paraphernalia used by the markers. By having the house established at the near butt the markers on their way to the different pits can take their material with them and return them to the building on their way out.

(c) The other building should be placed in rear of the firing-line and should be used as a store house for range flags, extra targets, extra disks, cocoa mats, and other paraphernalia used by the riflemen, or required to replace shortages in the pits. The building at the pit should be big enough to accommodate the *C* target; the one at the firing-line need not be as large, as much stuff is not required to be stored.

(d) No provision should be made at either building for the storage of rifles, as in order to have a proper building for this purpose would necessitate a much more expensive style of construction. If a building of this sort is contemplated, it should be only in cases of where the building at the firing point would be more of the nature of a club house for the local company and provision made for an attendant. The construction of a club house is governed entirely by local conditions, so it need not be discussed more fully.

225. A company range being a small affair, it is unnecessary to tunnel in order to connect the firing-lines and pits.

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CHAPTER XVII.

Prominent Ranges.

226. It has been thought advisable to give a rough description of some of the most prominent ranges in the United States and elsewhere that are being used at present.

Bisley.

(See plate XXIV, page 105.)

227. Bisley range, England, is one of the largest ranges in the world, consisting of several separate and distinct fields, every one of which could be called a range by itself. Each of these sections is what is known as the continuous butt, firing points in echelon, type. This, of course, does not refer to the small space given up to miniature rifle shooting and running deer target on the left of the Stickledown range. The Stickledown range itself is given up almost exclusively to long range shooting from 800 to 1100 yards.

228. The situation of the range is not ideal, as the winds are exceedingly tricky. This, of course, is no detriment, but in reality of great advantage, as a means of instruction. The firing points, due to the slope of the ground, are terraced toward the right of the range in order to give a proper view of the target from the stake to which the men are assigned to shoot at certain targets.

229. The next part of the range is commonly known as the Century butt, due to its having one hundred mid

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range targets in one butt. This is also of the continuous butt, firing points in echelon, type. Immediately on the left of the Century butt, between it and the Stickledown, is a small butt for 200 yard shooting. Still farther to the right of this, and shooting in an entirely different direction, is another butt commonly called Siberia. This butt is given up to shooting at 500 and 600 yards almost exclusively.

230. The shooting of this range is in a northwesterly direction, although each section departs slightly from that, the general direction.

Rockliffe.

(See plate XXV, page 106.)

231. The Rockliffe range is one of the best examples of the continuous butt, firing points in echelon, type. The shooting is done from 200 yards back to 1000, and several firing points are built up between bulkheads. This range has very tricky winds, due to the location, the river being on one side on which there is always a current of air, and woods on the other three sides. It is well flagged, and a splendid range to run a competition where all competitors are shooting at the same range at the same time.

Camp Logan.

(See plate XXVI, page 107.)

232. Camp Logan Rifle Range is very similar to Sea Girt in its general appearance. It is of the continuous firing-line, butt in echelon, type, only in this case the one firing-line includes the 800 yard range, it being only necessary to move back shooting at 1000 yards. There

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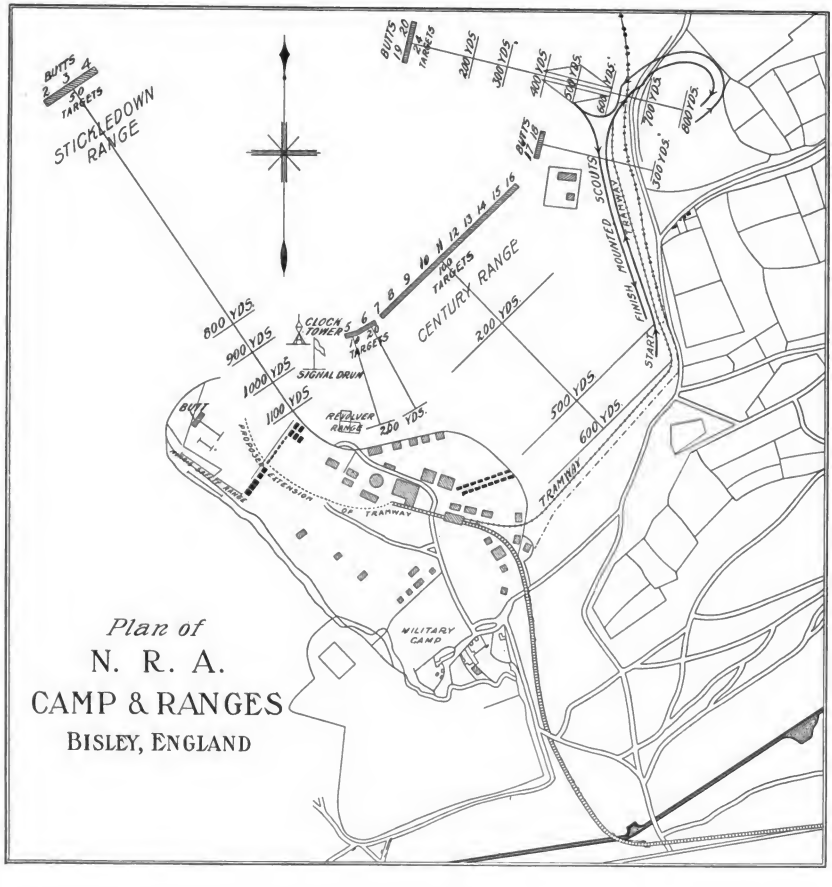

PLATE XXIV.

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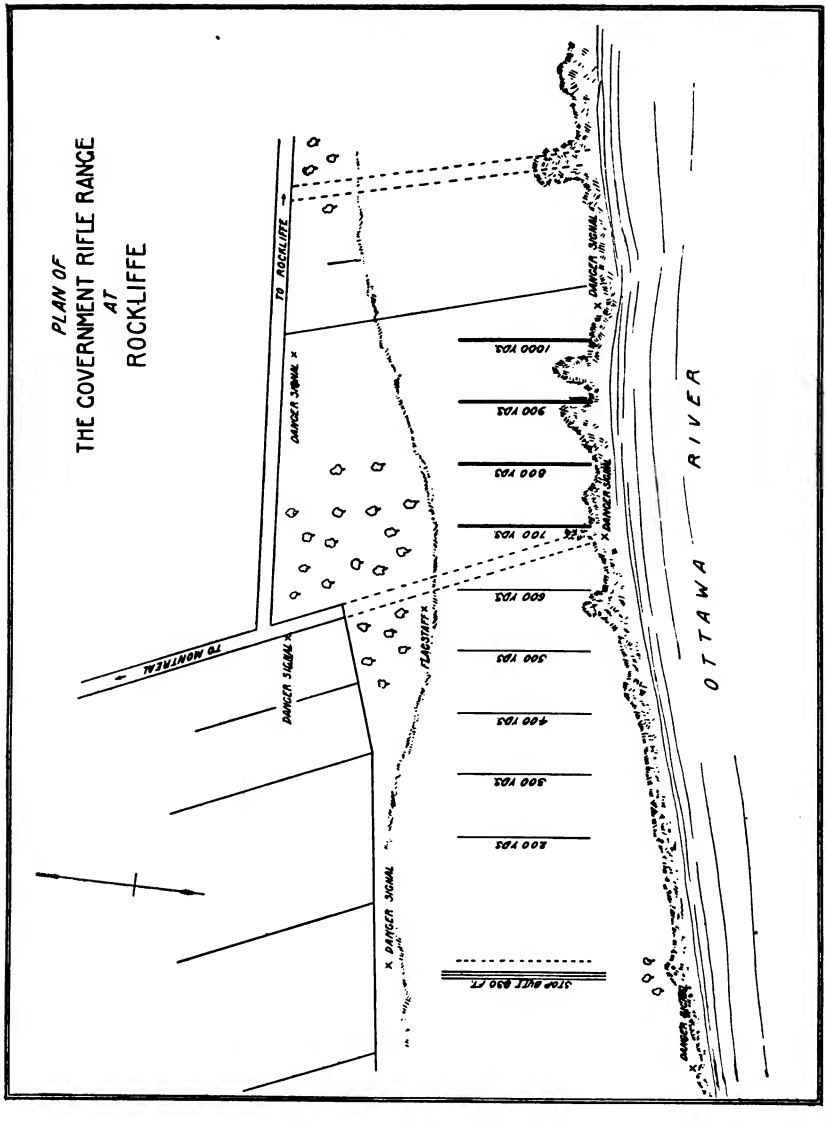

PLATE XXV.

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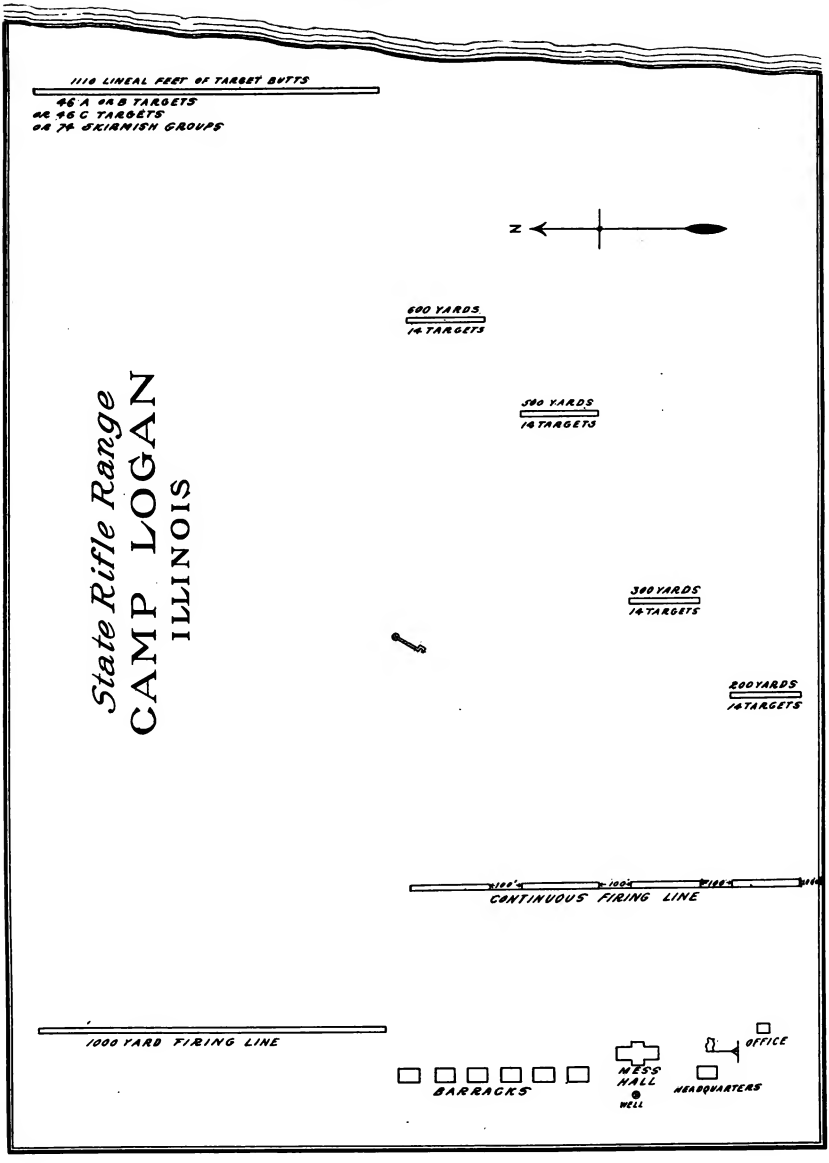

State Rifle Range
CAMP LOGAN
ILLINOIS

PLATE XXVI.

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is no cross fire. The skirmish field is located between the mid range and the long range, and firing can be conducted on all ranges at the same time. The shooting is east, in a general easterly direction, and it has a natural backstop, Lake Michigan. The range is fairly well flagged. The ground is very level.

Fort Riley.

233. The National Match Range at Fort Riley, which was specially constructed for the National Match of 1904, was located on an ideal piece of ground for the purpose. The skirmish field was as fine as could be procured for this purpose, being as level as a billiard table. This range was of the continuous butt, firing point in echelon, type, was very well flagged, and had as a natural backstop a bluff about 50 feet high with perhaps miles of prairie in the rear. The general direction of the shooting was north.

Saunder's Range.

(See plate XXVII.)

234. Saunder's Range, Glen Burnie, Md., is a good example of a continuous firing-line, butt in echelon, type, adapted for class firing for small organizations. The range has been cut out of the woods, and depends on this for its backstop, although artificial backstops have been thrown up immediately in rear of each separate butt. The range is not well flagged, as a range situated in the position of this one requires special attention to flagging. One objection to this range is that when skirmish fire is being conducted, it necessitates the closing of the long range.

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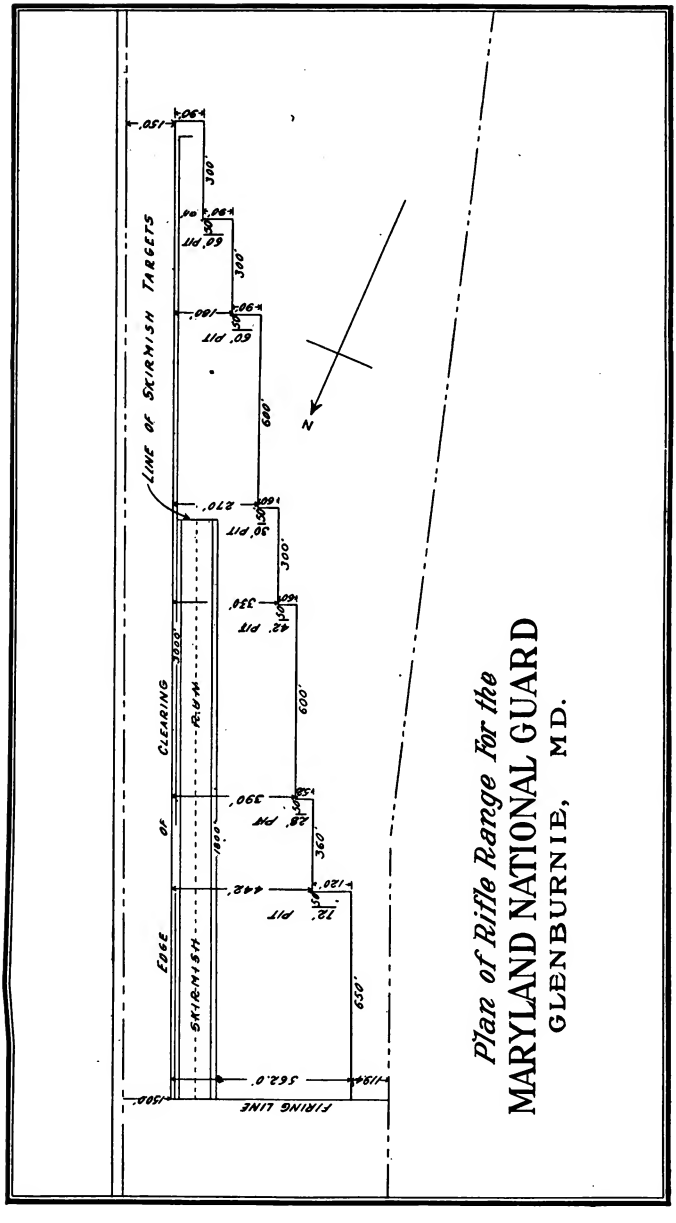

PLATE XXVII.

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Sea Girt.

235. Sea Girt Rifle Range is a fair example of a range put to all sorts of uses that in the original plans were never intended. The range was originally built as a strict example of the firing points on one line, butts in echelon, type, and this style of firing was continued at 200, 300, 500 and 600 yards. It has a natural backstop, the Atlantic Ocean.

236. A revolver range of the same type has been placed to the right of the 200 yard firing points. In addition to this, the firing points have been carried back for 800, 900, 1000, 1100 and 1200 yards, using the same line of butts as before for these new targets. In the case of the last long range targets added, the firing at the right of the group of long range targets crosses the line of fire for the mid ranges. These long range targets are also being continually hit by shots that pass through the 200 and 300 yard targets, strike the sand in rear and ricochet into the targets, that is, provided the firing is going on at these ranges at the same time.

237. The skirmish field is located to the left and is crossed by the firing of the left mid range and long range targets. This field in itself is also used for short and mid range and also long range shooting. The reason for all this cross fire is the fact that the area is too small for the number of targets as arranged. In addition to this, three targets have been placed to the extreme right of entire range, the firing-line being built out between bulkheads to the right of the road. The firing at these targets is across the Manasquan Creek.

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238. The direction of fire of this range is east, which is not the best in the world, but the location of this range would almost preclude firing in any other direction. The range is fairly well flagged, but in some ways does not represent the best range construction.

Camp Perry.

(See plate XXVIIa.)

239. This range is without doubt the best example of a continuous firing-line, butts in echelon, range that there is in the country. Each section of this range is put aside to serve but one purpose. This range has a natural backstop, Lake Erie, which has shoal water for some distance from the shore, thus rendering it unnavigable for vessels of any size. The butts are of cement construction, of a very good type.

240. As the range at present stands, on the right there are revolver targets at 15, 25, 50 and 75 yards, all from one firing point. The 200 yard range then begins, this being 50 targets in one butt. To the left of this there are a few targets at 300 and a few at 500, these to be used merely for matches during the big meeting, the 600 yard butt to the left of these having 50 targets in one pit. This 600 yard range is also used as the skirmish field, the targets being mounted on the regulation "B" carrier. In fact, during the National Match in 1907 experiments were made with the black silhouette figures pasted on the heavy pasteboard instead of the iron silhouette frames, thus eliminating one great source of danger. To the left of this is a long range butt established at 800 yards. This has 50 targets in one butt. To the left of this is another butt at 1000

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yards with 50 targets. The entire range uses the single target system, which is found to be more satisfactory than any other. The range is entirely equipped with targets of metal construction.

241. In all the butts the targets seem to have been placed too close to one another, thus not giving enough room between targets. Also what seems to be the fault with most ranges is the fact that in the planning of the range there was evidently no provision made for flagging of any sort; in other words, no sections or strips were allowed in the plans to permit of the proper flying of flags. Like many other ranges the flagging is ridiculous.

242. The shooting is in a general northerly direction.

243. On the long range butts, buzzer systems are installed, having an electric push button and buzzer for each target.

Guantanamo Range.

(See plate XXVIII.)

244. This range, built for the use of the U. S. Navy while on its winter cruise in the Caribbean, is in some respects very much like the Bisley Range; that is, a large piece of land has been set aside, and different ranges constructed within the limits of the ground. This range is far from complete, but from present indications, when finished, will be the largest rifle range in the world, and also the most complete. The firing is in a general easterly direction.

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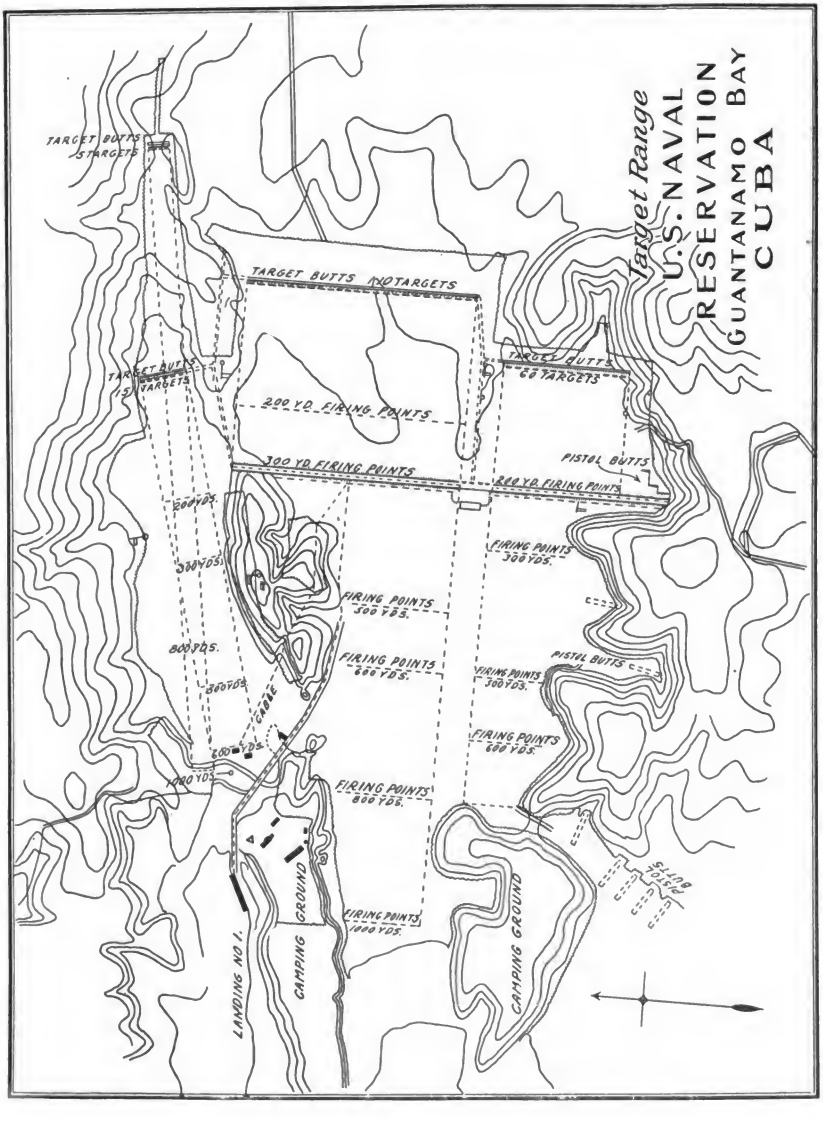

PLATE XXVIII.

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CHAPTER XVIII.

Operation of Range.

245. We will now go through the operation of an ideal range completely fitted, in such a manner as a range would be run on a day of large competition.

246. At seven o'clock the markers report to the Chief Pit Officer for their target assignments and instructions. They then proceed to the pits and get things in readiness as follows: They get out the targets, marking-disks, danger flag, ricochet flag, spotters and pasters. After having carried all this paraphernalia to the several targets, the non-commissioned officers in charge of each target have the targets properly hung in the carriers. The non-commissioned officers then see that the signal flags, marking staves and disks and pasters are provided, and in good order. They will then display the danger signals, and on examining the targets carefully will place pasters over any old shot holes, or, if necessary, put on a new paper target. Having everything in readiness they will wait for instructions from the pit officers.

247. The officers assigned to the pits report at 7.15 o'clock in the morning to the Chief Pit Officer, who gives them their special instructions for the day, and assigns them to targets. In no case should a pit officer have more than two targets to look after.

248. The pit officers will report in the butts immediately, and receive the reports of the non-commissioned officers in charge of the targets to which they have been

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assigned. At 7.45 they will have the danger signals waved and the targets placed in position for firing. At this time the Chief Pit Officer will call up the Chief Range Officer and notify him that everything is in readiness.

249. At seven o'clock the scorers will report to the Chief Range Officer for instructions and assignments. There should be one scorer to every firing point. At the same time they will procure from the Chief Scorer the score-boards, chalk, camp-stools, telescopes, danger flags and indelible lead-pencils. After receiving instructions they will report promptly to their different targets at the different firing-lines, and put up the danger signal. At 7.15 the range officers will report to the Chief Range Officer for instructions and target assignment. No range officer should have more than two targets for supervision. Range officers will then report to the firing-line in rear of their targets and see that the scorers are in position and everything is in readiness. They will then inform the Chief Range Officer that such is the case. The competitors who have been ordered to report a half an hour before their time for firing are assigned to their targets at 7.45. The Chief Range Officer having been notified by the Chief Pit Officer that everything is in readiness in the pit, then cautions the range officers to get ready for the firing. The range officers in turn caution the contestants and scorers on their targets.

250. At seven o'clock the men assigned to the telephone detail report to the officer or non-commissioned officer assigned as Chief of that section for assignments

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and instructions. They then procure from him the telephones and connecting links for telephones in the pit and on the firing-line. They then promptly proceed to their different stations, set the telephone in place, connect the plugs, and see that everything is in working order. The Chief of the signal section or his assistants receive the reports of the different signal men, and in case anything is found out of order they have it replaced promptly so as to insure there being no delay.

251. At 7.55 the Chief Range Officer has "Attention" sounded on the trumpet and promptly at 8 o'clock commence firing. When "Attention" is sounded the telephone men at the firing point notify those in the pit that the firing is about to commence. The marking is conducted according to the firing regulations.

252. When for any reason it is necessary to cause cessation of fire, danger flags should be ordered up at the firing-line by the Chief Range Officer, and all the flags at each firing point promptly put up, the trumpet in the meantime blowing "cease firing." The pit officer is then notified, and he orders all danger signals displayed, and targets pulled half way.

253. At twelve o'clock the range should be closed for one hour and a half, using the above method, and reopened at one-thirty, with a fresh lot of markers and scorers, if possible, starting the men to the pit in sufficient time to be sure that everything is in readiness to start at 1.30.

254. In closing the range at twelve and six or whatever time is deemed best in the afternoon, depending on the light, men firing should not be stopped in the mid-

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dle of strings, but in all cases should be allowed to finish. It is well in this respect not to allow new strings to be started after twenty minutes before closing time.

255. When the range is closed at night, all scorers turn in their material to the chief scorer. The markers unship targets and bring all their paraphernalia to the storage houses, reporting anything out of order or missing to the chief marker, so that the same can be remedied in time for the next day's shoot.

256. The telephone detail remains in place until notified that all is secure in the pit; it then disconnects instruments, sees that the contact points are properly housed, reports anything not in order to the chief of the signal section, and turns over instruments to him.

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CHAPTER XIX.

Running a Competition.

257. Although this work is on range construction, it has been thought advisable to give an idea of how a competition should be run with the least possible trouble, and without too much unnecessary book work. The chapter devoted to the proper running of a range will pretty well cover such details as are within the performance of range officers, scorers, markers and manipulation of targets, and such. This is merely devoted to points not covered.

258. Matches as a rule are divided into two general classes: squadded and unsquadded matches. The unsquadded matches are again divided into two classes known as single entry and re-entry matches.

259. A squadded match requires more preliminary work than the other types and is one most liable to cause delay in its proper running. All entries for squadded matches should be closed by twelve o'clock noon of the day before the match is held. This, however, is not a positive rule, as it is sometimes advisable to close the entries even earlier than this. As fast as entries come in, it is advisable to promptly make out the competitor's score card and also a squadding ticket. As soon as all entries are in and all squadding tickets and score cards made out the tickets are shuffled and then distributed in pairs according to the number of targets it will be necessary to use in the match. It is always

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advisable in this connection to allow plenty of targets for a squadded competition, giving all competitors an equal chance, rather than crowd too many men on one target or have so many relays that the match cannot be finished properly.

260. The score cards of the competitors are then placed in pairs corresponding to the pairs of squadding tickets marked with the approximate time that will be necessary for competitors to appear at the firing points, unless the match is to be one where all competitors fire at the same target during the same period. The score cards and squadding tickets are then marked for the target and position, whether on the right or left, and relays, in case the match is going to be run on the relay system, or if all competitors take part in the competition at the same time the competitors at each target will be numbered in position from one up to the number of men on the target. Perhaps in most cases the relay system would seem to be the best, but fair-minded competitors always believe that the best results are achieved by having all competitors undergo the same changes of conditions that may take place during the progress of the match at the same time, also believing that the man who, when it becomes necessary, has to calculate his shot each time is more entitled to the win than in the case where two men are alternating, catching perhaps much easier conditions than men who follow them or precede them. This style of firing also develops deliberation and coolness, whereas the relay system, with the consequent time lost by each pair in getting ready for their shooting, is more apt to lead to hurried and unsettled firing.

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261. Whichever system is used, however, after comparing the score cards with the squadding tickets to verify the assignments, the score cards are placed in an envelope with the number of the ticket and name of the match clearly marked on the outside. The squadding tickets are then arranged in alphabetical order and placed in envelopes alphabetically. These envelopes are then laid out in some convenient spot where competitors assemble, so that they can secure their own squadding cards for the match held the next day.

262. Entries for squadding matches are made on specially printed entry blanks for this purpose, in which case the competitor gives his name, rank, organization and such other information as may be necessary. In case the match should be a "tyro" match he must give sufficient information to enable the proper officers to investigate and see that he is eligible to shoot in a "tyro" match.

263. When the competition takes place, the competitors having reported at the proper time as designated by their squadding tickets, the envelopes containing the score cards are turned over to range officers assigned to those targets. Range officers place these cards in the hands of the scorers; scorers call the names of the first two competitors, or if necessary, all competitors, and get them placed properly at the target ready to begin firing. This, however, has been more fully explained in the chapter on that subject.

264. It is well to remember in a squadded competition that sufficient time should be allowed for all probable entries. It is never wise to take the actual

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time allowed per shot for each competitor and put that down as the total time required to run the match. If the match is for more than one range there is always great delay in changing one range to another, and the final change cannot be made until the last competitor firing at one range has completed his score before moving to the next. Of course, with a range with firing points on one line and butts in echelon, where the men are firing in relays, competitors finishing at one range can move on to the next as soon as one is finished, and continue that part of the match. It is always well to allow from twenty minutes to half an hour for changing of ranges; then if less time is consumed that time will be so much gained. This may seem unduly long, but when the range officers collect their scorers and have them move their score-boards and other paraphernalia they may have to the new firing points, this of course based on the supposition that it is necessary so to do, and by the time the competitors have placed themselves in position to begin firing and the signal is finally given to commence firing, it will be found to be very close on to one-half hour.

265. The regulations provide that at the short and mid range, contestants shall be allowed time at the rate of one minute per shot. If the match is a ten shot match at any one range a relay of two men would then on paper require 10 minutes apiece for their 10 scoring shots, 2 minutes apiece for their sighting shots, making a total of 12 minutes each or 24 minutes for both men. If each pair is allowed half an hour actual time for firing from the time they are in position until their last shot, with

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the delays which usually take place, it will not be found any too much time.

266. At the long range competitors are allowed one minute and a half a shot, and in a ten shot match, one relay of two competitors would then require on paper 15 minutes each for their ten shots and 3 minutes for the two sighting shots, making 36 minutes actual time for the score. If this time is increased to ¾ of an hour, it will not be found to be any too much. Firing on the basis of 30 minutes for a pair, with 10 shots at short and mid range, and 45 minutes for a pair at long range, or allowing this time for each two men assigned to these targets, with the additional time for changing from one range to another, there will be very little chance for a competition running over, as might be otherwise the case.

267. In shooting rapid fire, a pair require from 10 to 15 minutes, this of course covering the time for the getting in readiness of the men, for the changing of the target, the marking, the pasting, scoring, and in case targets have to be re-marked, this time is increased. There have been instances where five skirmish runs have been conducted in an hour. This, however, without any satisfaction to the men taking part in the run. Four runs can be made, but it is never advisable to allow for more than three runs an hour.

Unsquadded Match.

268. The first under the head of unsquadded matches are what are known as single entry matches, that is, matches where one ticket can be shot; but a score can be

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shot on this ticket at any time during the meeting. In this case, there is no squadding ticket. The competitor fills out an application blank and passes it in to the statistical officer with his entrance fee, receiving a card on which his name has been filled in by the statistical clerks. The competitor takes this score card, and at any time during the meeting that shooting is allowed at the range that this ticket calls for he can present the ticket to the range officer, be assigned to a target, and fire his score.

269. The second style of unsquadded competition is what is known as a re-entry. In this case, the score cards are numbered consecutively, the competitors purchasing whatever cards for different matches they may require. They write their own names on these cards before they present them at the firing point. There is no occasion to cause delay at windows where these tickets are sold by having the clerks write the name of the competitor on the score card and then enter it in the book. If the competitor presents his score card at a firing point to a range officer without his name on it, it merely becomes necessary for him to write his name on it, then and there, to make the card valid. Numbers of ranges have been run with too much unnecessary bookkeeping in this respect. It should make no difference to the people running the range who pays for the tickets. All they desire is the score card returned to the office with the man's name on it and his score properly certified to by the range officer.

270. One objection has been cited against this style of selling tickets in regard to tyro matches, but should

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hold no weight. If a man shoots a ticket in a match in which he is not eligible to shoot, his score cards are not only of no value, but in addition he lays himself open to the rule covering men shooting under false pretenses. This is a matter that can be adjusted at the statistical office, and should not be the cause for delay at the time of the purchase of the tickets. In addition, at large meets, it cannot be expected that clerks selling tickets will know whether a competitor is entitled to shoot in a tyro match or not. That is a matter for investigation. It merely is necessary to have published in the progress of matches and also posted on bulletin boards in plain view, the fact that in matches open only to tyros or with special restrictions scores of men eligible under those restrictions only will be considered, and others thrown out.

271. A man desiring to shoot his ticket in a re-entry match presents his score card at the firing point of the range at which the match is to be held at any time when said range is open, being sure his name is on the score card. He is then assigned to a target by the range officer and shoots his score.

272. All skirmishing is naturally squadded, whether it is a re-entry skirmish match or not. The men present themselves at the firing point, in case of a squadded match at a specified time, and make the run according to regulations under the proper officers at that time.

273. In unsquadded skirmish competitions, however, men present themselves, and are assigned to groups for skirmish runs as they come up. As soon as the one run is filled, it is then sent down the range, the next com-

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petitors arriving on the ground being assigned to positions for the next run.

274. The styles of score cards recommended are as follows: Team cards; squadded matches; single entry squadded matches; re-entry matches; tyro re-entry matches. It will be noticed in all instances the score cards are in duplicate.

275. Team matches are conducted on the same general principles as a squadded match in relays, except in this instance a sufficient time is allowed each team to cover the shooting of its men. These men come up to the firing point in pairs and retire in the same manner. The total time allowed for this being slightly more than the actual time necessary for the shooting of these men; but it is well, however, to realize the fact that thirty minutes for a pair to shoot ten shots at short and mid range and 45 minutes for a pair to shoot ten shots at long range is a good rule to follow.

276. Score cards for team matches should be made out in duplicate, one copy being kept by the statistical officer, the other copy by the team captain. Entries for teams with proper certificates of elegibility should be made not later than twelve o'clock noon the day preceding the beginning of the match.

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CHAPTER XX.

Indoor Range.

277. The construction of an indoor rifle gallery is a very simple proposition when it is considered that the one essential is a backstop. Any other improvement such as trolley system, signal outfit, etc., while convenient, is not absolutely necessary.

278. Backstops are divided into two classes: first, requiring marker; second, not requiring marker. In the first class all the larger ranges would be considered, especially where the range is of fifty yards or more, the idea being to use the sash system of target with room for a man to manipulate the same. This sash system of target is not strictly the same as outdoor targets, but more on the plan of the two sashes of a window sliding in grooves, the uprights supporting these grooves, being protected from the firing point by bulkheads. No general form for this type of backstop can be given, except that when used a proper pit should be provided for the protection of the marker, and the bullet catcher in this case should be of such form as to preclude the possibility of the splash of the bullet injuring him. The type of bullet catcher usually recommended is on the principle of a funnel with one side continuing to a spiral in which the force of the bullet is expended. Plate XXIX, gives a plan of this form of backstop.

279. Where a backstop of this sort is used, there is usually some system of signalling necessary in order to

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complete the range, as the use of the ordinary marking-disks, while necessary for the shooter, will in no way help the man scoring. This is usually remedied by using an annunciator system or some other form of electric signalling device by which the value of the shot is signalled from the butt to the firing point. As the construction of an indoor range of this form is a rather expensive proposition, and only recommended where a large armory is being constructed, the actual details will not be gone into any further, as no plans could be prepared that would suit all cases.

280. The plates XXIX and XXX here shown are of the indoor range in the Seventy-first Regiment Armory, New York City, which we believe to be the latest type of indoor gallery of this form in use. We reproduce these plates through the courtesy of Clinton & Russell, Architects, New York.

281. A type of indoor range which will be more apt to be used than the above is the one where the backstop is without protection for marker, and in which case some system of trolley is recommended to carry a small paper target from the firing point to the backstop. Backstops of this type are very easy to construct and also very cheap.

282. The first form given is of the simplest construction, the bullet catcher consisting of an inclined plane with an apron at the bottom to throw the bullets off into a box or on the ground. (See plate XXXI, page 128.) The steel for this plate need not be over ¼ inch in thickness, as the incline is sufficient to withstand a fairly heavy gallery charge. The protection

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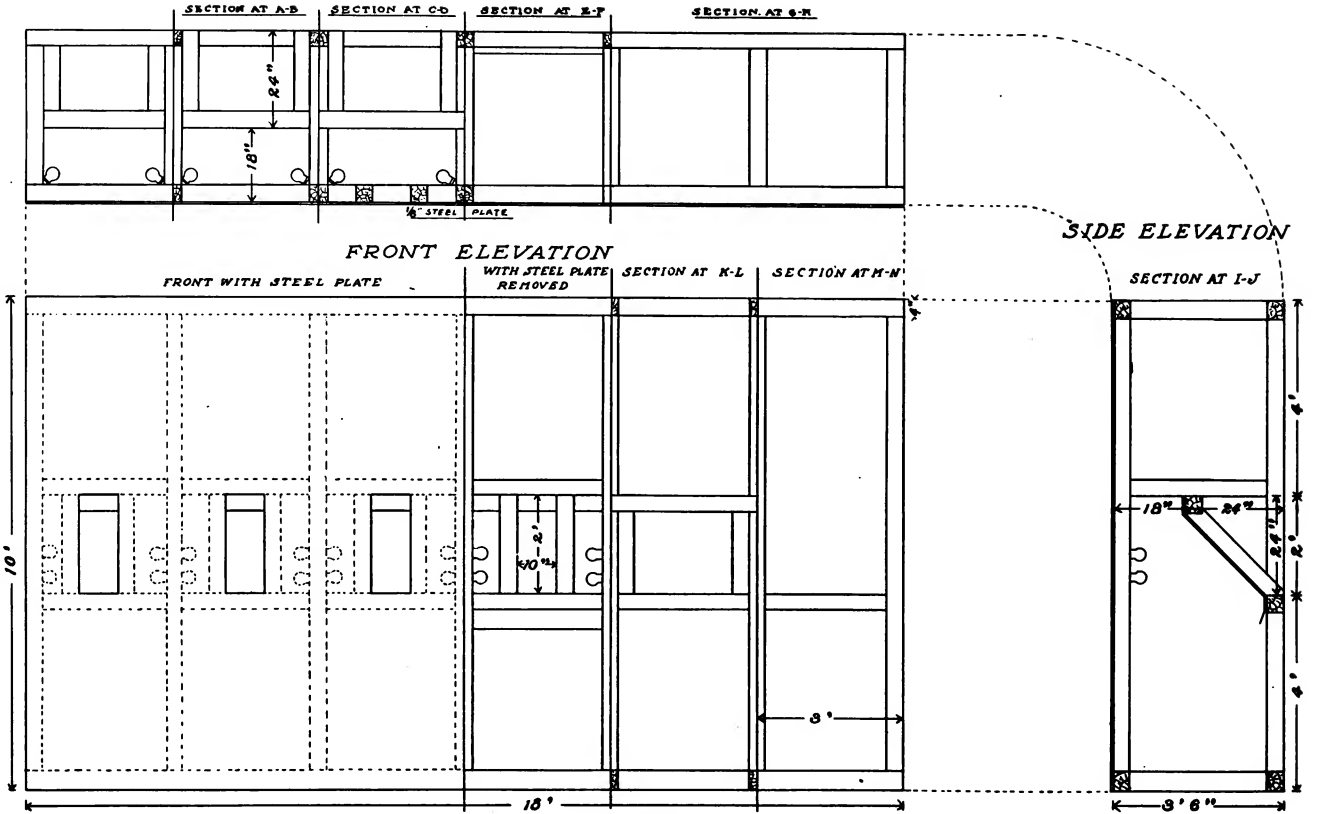

PLATE XXXI.

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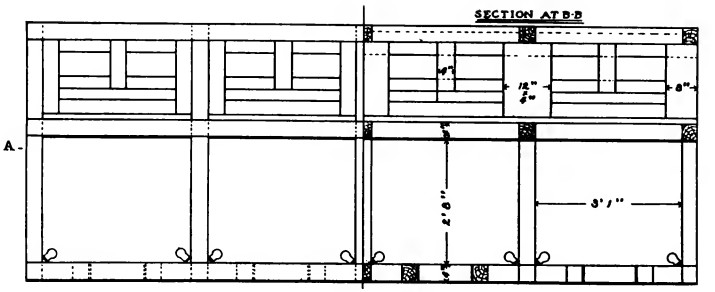

FRONT ELEVATION

SIDE ELEVATION

SECTION AT C-C

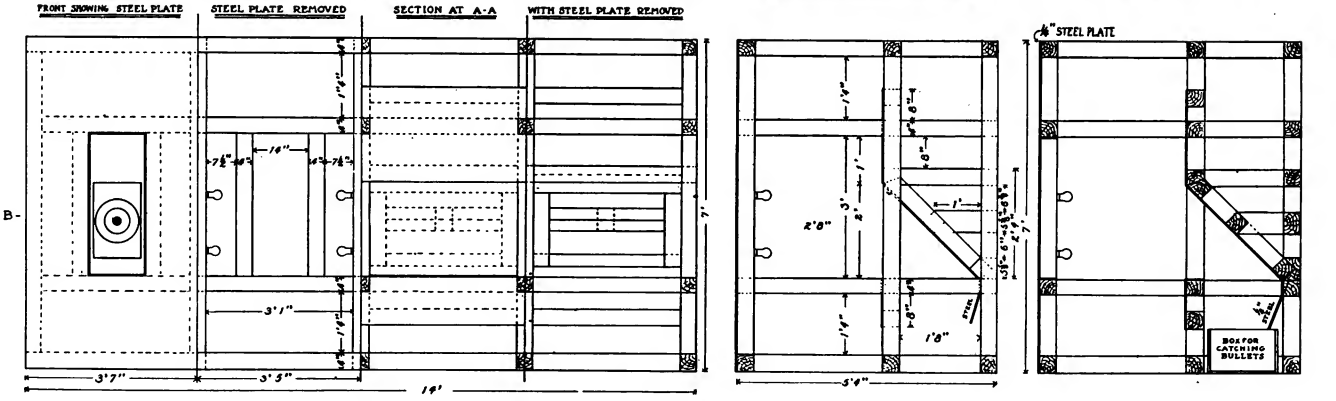

PLATE XXXII.

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plates of ⅛ inch steel in front are merely provided to protect the electric lights and catch the occasional wild shots. The wood and framework to support these steel plates need not be mortised and tenoned, but merely butt-jointed and nailed, and can be made of hemlock or spruce or some other cheap wood. This framework should extend from the floor to the ceiling in order to stop any extremely wild shot from going beyond the backstop, the inclined plate being placed behind the opening in such a manner that any shot passing through the opening from the firing point will be stopped. The lights in this form of backstop are placed in such a way as to throw the light directly on the face of the target, and at the same time be protected from the bullets from the firing point.

283. With this form of backstop, as said before, some form of trolley system is recommended, in order to save the walking to and fro from the firing point, which necessitates the cessation of fire at all targets. The trolley system is not absolutely necessary, but a range built without it should certainly have some provision for its future installation. It consists of a couple of wires on which a carrier of some form holding a target can be slid from the firing point to the backstop. The movements of this carrier are controlled by an endless cord passing over a grooved wheel, this grooved wheel being actuated by a crank at the firing point. When this trolley system is used it is necessary that a timber of some sort cross the room at the firing point to which the wires supporting the carriers are fastened, and also some uprights from the floor to this

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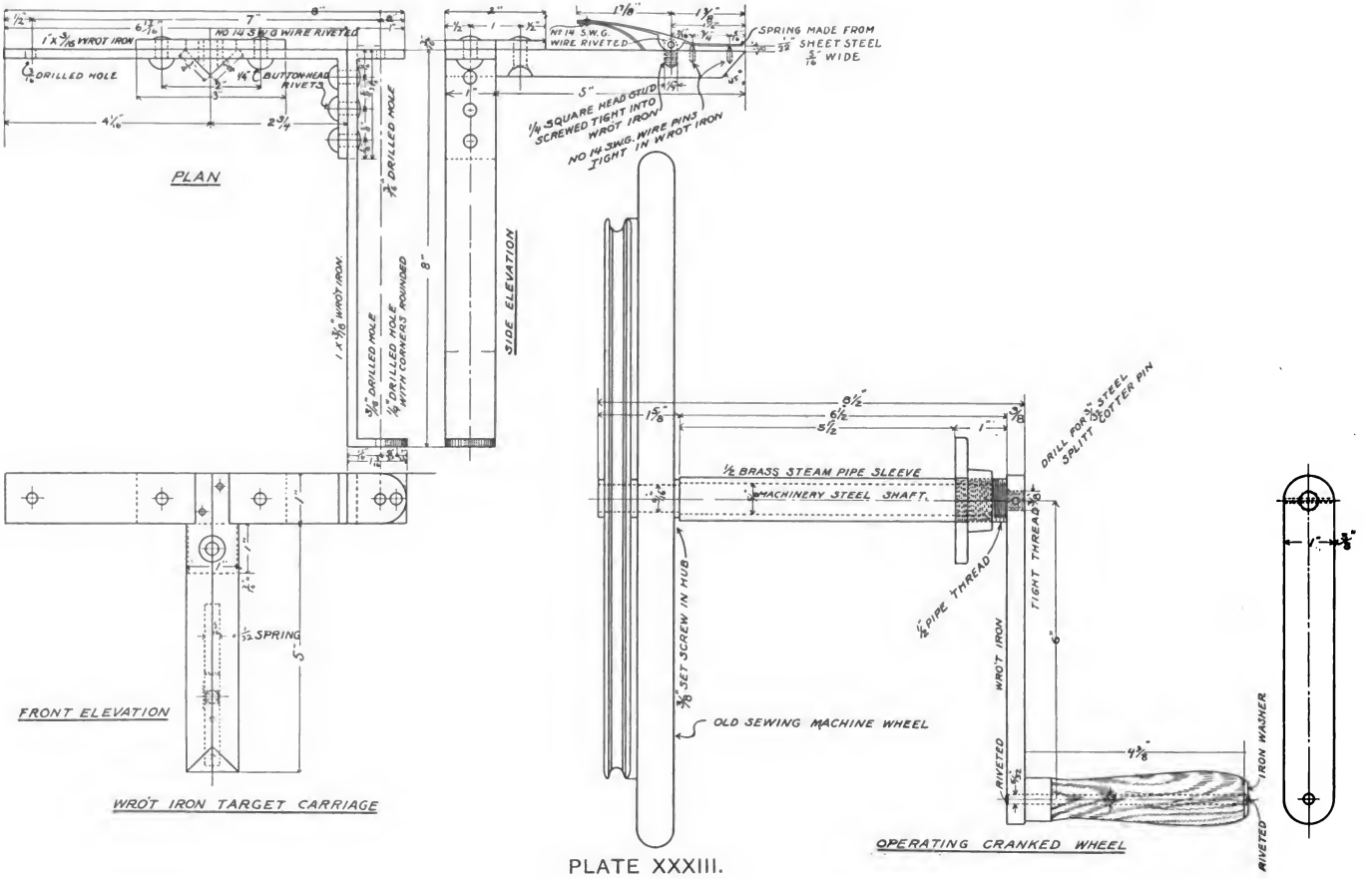

PLATE XXXIII.

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cross beam, which will support the grooved wheels and the crank. A further improvement is to board up the firing point, allowing openings for the rifle-men at the different firing points to shoot through. This will also give ample provision for locating telescopes at the firing point for each target. Improvements such as this allow of considerable latitude, but in all cases the construction is so simple as not to require any special discussion, except to say that the endless cord should be held in position by small pulleys in such a way that the cord which is fastened to the carrier should travel in a straight line parallel with the wires on which the carrier rides. (See plate XXXIV, page 133.)

284. A simple form of carrier and one which can be made very simply is shown in plate XXXIII (page 131). The plate is self-explanatory, all dimensions being given.

285. A backstop is sometimes required that will withstand heavier charges than the one shown in plate XXXI. It only differs from the other in the fact that there are more timbers and more woodwork braces to take up the shock. Its only advantage over the other one is that it is less liable to need repair in a given time.

286. As most of the indoor ranges established will not be over fifty or sixty feet or perhaps seventy-five feet, either of the last two types of backstop will be all that is necessary. This is especially so where the .22 caliber Springfield rifle is used. With a short range of this form, it is recommended that for firing kneeling and prone some form of platform be built which can be slid up to the firing point for the men to shoot from.

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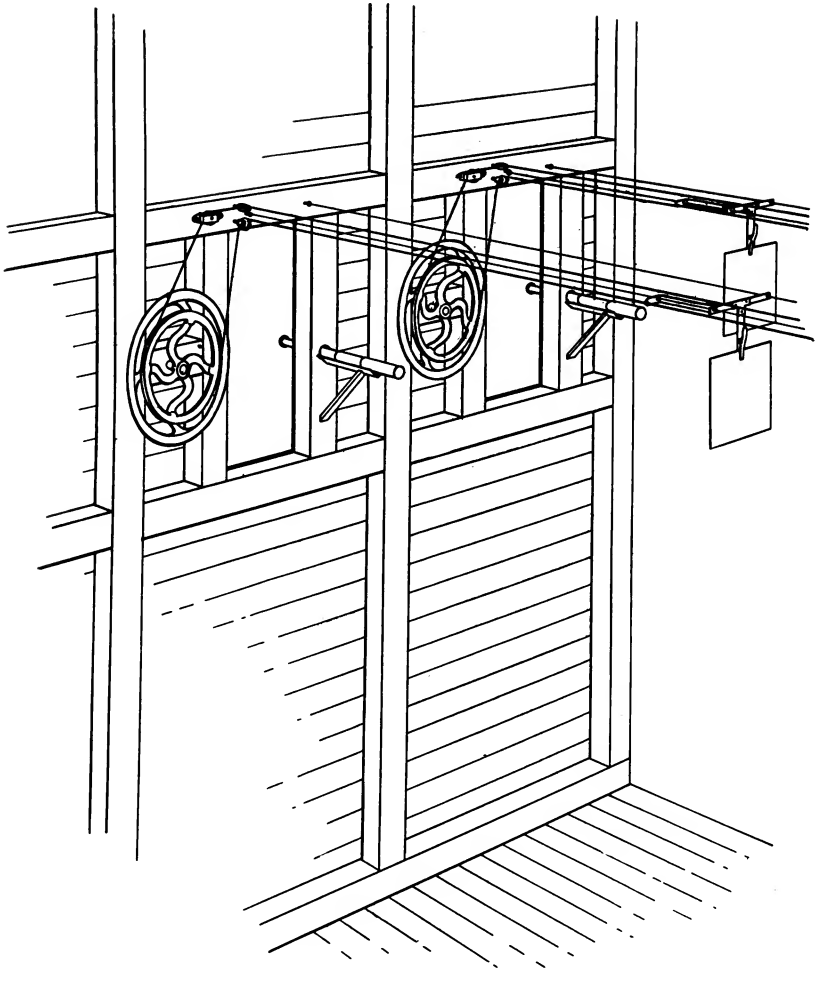

PLATE XXXIV.

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Do not be afraid of using too much lumber in building this platform, as great rigidity and stiffness is a necessity and can only be accomplished where plenty of lumber is used.

287. In lighting an indoor gallery it is advisable to have all lights controlled from the firing point, this of course referring to electric lights, as in no case is any other form of light recommended unless it is impossible to get electricity. The use of reflectors in an indoor gallery is not recommended. They are apt to concentrate the light in patches on the fact of the target, these patches being reflected back into the shooter's eyes. If the backing on which the lights are mounted is painted white it will serve the purpose to much better advantage. It is not necessary with either .22 caliber ammunition or "Marksman" or "Unique" powder in reduced loads in the .30 caliber to provide for any form of blower or exhaust, so therefore none is recommended.

288. The use of end timbers for a backstop, while it may at first seem cheap, has generally been found to be rather expensive when it comes to the necessity of replacing them. Sand in boxes, while a very good form of backstop, becomes a nuisance after awhile and in no way can it be considered as satisfactory as one of the three forms of backstop shown. But where either of these types is to be used it does not require any special description for the installation.

289. There is one thing to be remembered in all indoor range construction; that is, that a space of between 30 inches and 36 inches is needed for each man. Therefore, in providing for a certain number of targets if three feet is allowed for each it is ample.

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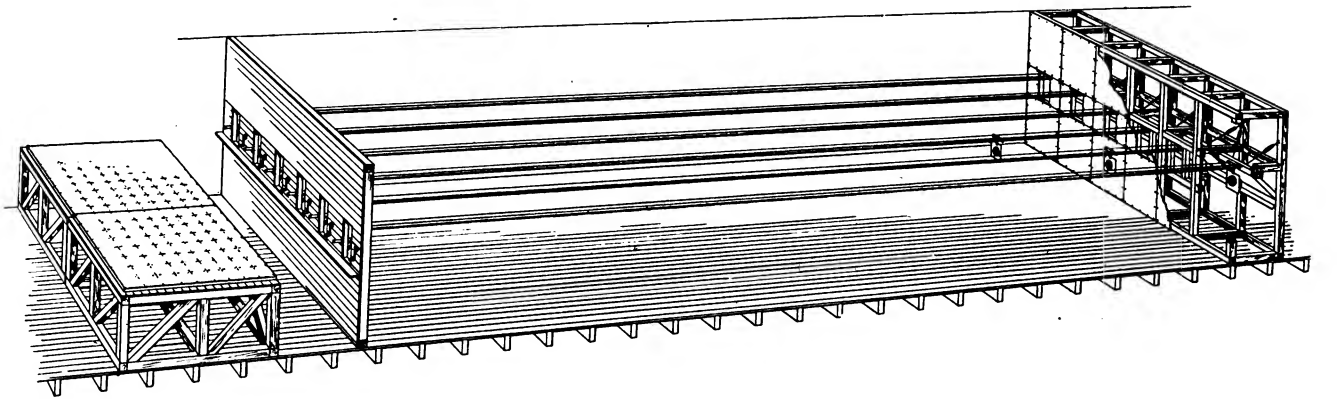

PLATE XXXV.

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Indoor Range for School-Boys.

290. There is no special type of range recommended for this purpose other than the cheapest form of backstop, as shown in plate XXXII (page 129). This is all that is required with a trolley system. As all this shooting is done with .22 caliber rifle ammunition and is usually properly supervised, no special preparation in regard to safety should be made other than would be on the ordinary indoor ranges. Plate XXXV (page 135) shows a perspective of an indoor range such as recommended for use of school-boys.

Buildings for Indoor Ranges.

291. On some of the Army posts and in certain sections of the country, it is sometimes advisable to put up a small building for an indoor range. Where such is the case, it is merely necessary to follow directions for the construction of the interior work, putting the whole in the cheapest form of frame building that can be constructed, preferably, light studding with corrugated iron sheeting for covering. Where it is necessary to erect buildings for indoor galleries and the strictest economy must be observed, it is only necessary to roof over the firing point and backstop, allowing the rest to be open. This, however, is not recommended as a permanent form of construction, but only temporary, as at some future time it is advisable that the same be covered over, thus making the range permanent.

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CHAPTER XXI.

Temporary Ranges.

292. While it is not recommended that anything in the nature of temporary construction be used for a range, it sometimes becomes necessary to do so when it is deemed of advantage to have rifle practice during a tour of camp duty which is not held on any permanent site. In a case of this sort there is not time for the construction of a permanent range, nor would it be advisable. Ships' companies will sometimes locate a temporary range in order to have rifle practice. In such cases as these a temporary range is better than none.

293. The entire proposition of the construction of a temporary range is a matter that requires a pretty thorough knowledge of range building in order to make the most of opportunities, and no particular type can be recommended that might in any way suit the case in hand, but by remembering the one axiom, safety, and never losing sight of this, some form of range can perhaps be constructed that will at least give practice in one kind of fire.

294. The question of safety is paramount, and it will be found that not every place can be adapted to this purpose. It is not always possible to choose the direction of fire, as above all things a temporary range requires a natural backstop.

295. In the matter of pits, they are at the most makeshifts, as the usual manner is to dig a small trench

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about four feet deep, throwing the earth in front in such a way as to protect a man in the pit, the size of this trench being determined by the type of target used. It is not supposed, in a case of this sort, that any regular form of target will be at hand. In making the targets the ingenuity of the range builder will be called on to devise some good form out of whatever material is at hand.

296. Captain W. C. Harllee, of the U. S. Marine Corps, has on numerous occasions constructed temporary ranges, using a type of swinging target modeled after the Parker, built of scrap, which has been found very satisfactory. In this way he has been able to conduct practice when otherwise it would have been impossible.

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CHAPTER XXII.

Surprise and Disappearing Targets.

297. Lt.-Col. Robt. K. Evans, U. S. Infantry, in his lecture delivered at the War College on February 17, 1909, and published in the Service periodicals, so plainly specifies the absolute necessity of infantry fire being supported by artillery fire that it seems not only strange but suicidal that our Government has not established ranges where such practice can be had. As Col. Evans points out, ours is the only nation of any magnitude which has not acquired and developed such ranges. Plots of ground five miles square are necessary for such work in order to secure absolute safety and to allow the field artillery to maneuver. Land for this purpose need not be level nor without timber; in fact, hills and valleys, woods and streams, are essential factors in giving suitable practice, if actual service conditions are to be simulated.

298. Government reservations of this size scattered through the United States are absolutely necessary, and will, we believe, be acquired in the near future. Such tracts of land are the logical places to install surprise and disappearing targets.

299. Our Ordnance Department is now working on such targets and no doubt will soon have some ready for installation. At present, although we have carefully gone over drawings and photographs of such targets used abroad, the information is too indefinite to enable

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it to be placed in this work. All, however, try to imitate what might happen in actual warfare: an armored train rolling from concealment into open view and then disappearing; a cavalry charge appearing over the brow of a hill and rolling toward the firing line; or crossing a certain space at right angles; targets the size of a man's head appearing over a trench and remaining for a certain time—these are generally made of steel; but Germany has tried inflated bladders or balloons and has apparently settled upon earthenware pots shaped like a man's head, which, of course, break into pieces when hit. In fact, there are many excellent ways to make rifle practice not only thoroughly instructive but actually entertaining and exhilarating if these targets are designed to give near-service conditions; mechanically easily operated and serviceable enough to stand repeated hits. Plugging away at a bull's-eye for a whole afternoon is not an exhilarating sport; it really is not an enthusiastic proposition.

300. Frequent visits to any .22 caliber shooting gallery at Coney Island, Atlantic City, or any of the various white cities scattered over this country will show that what the majority of shooters wish to hit is *something* moving—only the few try to ring the bell in the bull's-eye target.

301. Our present rifle ranges—level ground and, as a rule, danger from stray bullets to the community encircling the range—can still be utilized for surprise and disappearing targets. Skirmish banks can be used for head targets, the bank showing where the bullets are striking; armored trains and cavalry can be built to

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run along the face of any butt. All these are details which can be developed by the character of the range and the inventive genius which is so characteristic of this country.

302. Care should be exercised to prevent wild shots, and only sharpshooters or better should be allowed to practice on such targets.

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